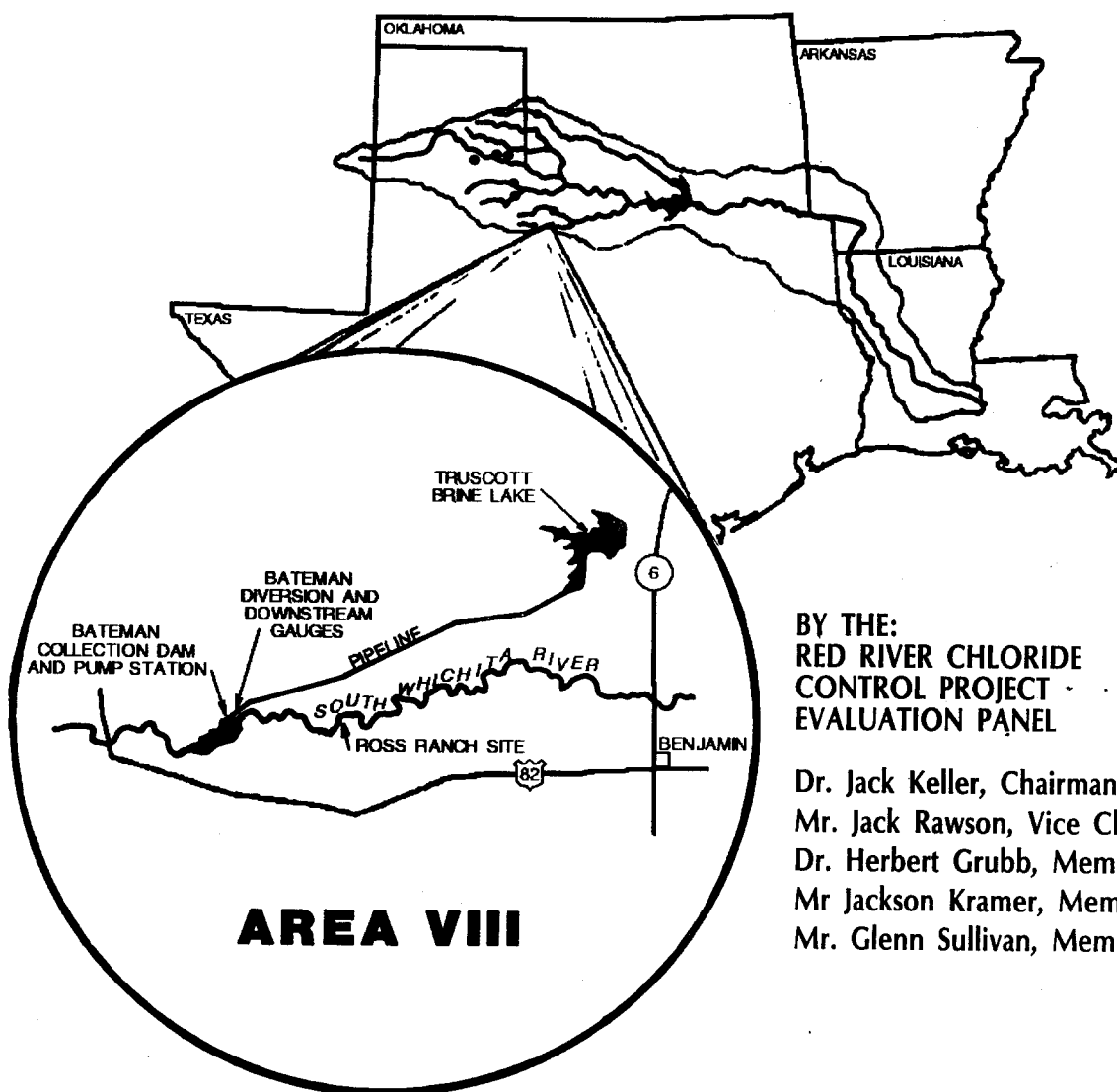

REPORT ON THE EVALUATION OF THE EFFECTIVENESS OF OPERATION OF AREA VIII RED RIVER CHLORIDE CONTROL PROJECT



BY THE:
RED RIVER CHLORIDE
CONTROL PROJECT
EVALUATION PANEL

Dr. Jack Keller, Chairman
Mr. Jack Rawson, Vice Chairman
Dr. Herbert Grubb, Member
Mr. Jackson Kramer, Member
Mr. Glenn Sullivan, Member

AUGUST 1988

RED RIVER CHLORIDE CONTROL PROJECT

EVALUATION PANEL

DR. JACK KELLER, CHAIRMAN
DR. HERBERT GRUBB, MEMBER

MR. JACK RAWSON, VICE CHAIRMAN
MR. JACKSON KRAMER, MEMBER
MR. GLENN SULLIVAN, MEMBER

August 8, 1988

Secretary of the Army
ATTN: Assistant for Civil Works
The Pentagon (Room 2E570)
Washington, D.C. 20310

Committee on Environment and
Public Works of the Senate
SD458 Dirksen--Senate Office Building
Washington, D.C. 20510

Committee on Public Works
and Transportation of the
House of Representatives
2165 Rayburn--House Office Building
Washington, D.C. 20515

Gentlemen:

We are pleased to submit the attached report of the Red River Chloride Control Project Evaluation Panel's findings in compliance with Section 1107 of P.L. 99-662. The report details the evaluation of the operational effectiveness of Area VIII of the Red River Chloride Control Project. The Project's objective is to improve the quality of water in the river by removal of salt pollutants. We found the operation of the completed works in Area VIII to be consistent with the Project benefits projected by the economic reanalysis in the U.S. Army Corps of Engineer Memorandum No. 25 of 1980. On the basis of these findings the Panel feels that proceeding with construction of the remaining elements of the Project is justified in accordance with the intent of Section 1107 of P.L. 99-662.

The report provides related background information for the Red River Chloride Control Project with particular emphasis on our analysis of the operational performance of the installed portions of the Project in Area VIII. (Almost 50 percent of the natural chlorides polluting Lake Kemp come from the saline springs and seeps of Area VIII.) The Panel visited the site to see the constructed facilities and met several times to review and provide guidance for the data collection and analysis process. Pertinent information on the history of the Panel's activities and excerpts from the minutes of the various meetings are included in the report.

The Panel decided that the analysis based on daily data collected during the first full year (May 1, 1987 through April 30, 1988) of operation of the Bateman Pump Station (which is where the saline water is removed from the river system) was sufficient to adequately assess the effectiveness of the installed facilities. The data studied quantifies the reduction of chlorides at gaging stations operated by the U.S. Geological Survey in cooperation with the Corps at both Bateman and approximately 50 river miles downstream at Benjamin. Flows were exceptionally high during May, June, and July 1987 and relatively low during the remainder of the test period. This was a fortunate event in that it provided both high- and low-flow conditions for evaluating the project's performance at Benjamin.

In addition to the 1987-88 data, sufficient chloride and flow data had been collected during water years 1971 through 1976 for utilizing in a simulation model to predict operational results. Simulation runs were made assuming the Bateman Pumping Station was operated in a similar manner during 1971-76 as it was during the evaluation period. This simulation resulted in an even greater reduction of the chloride load than occurred during the one-year evaluation period.

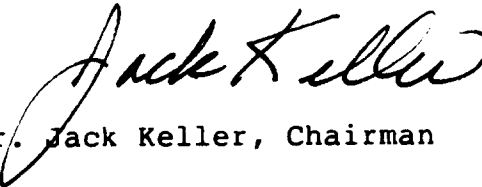
The principal findings of importance to the purpose of the Panel's task are:

- * The physical facilities necessary for collecting brine at Bateman and pumping it to Truscott Brine Lake are in place and functioning adequately. The operation of the pumping plant and pipeline has proven successful with very little down time.
- * The control system at the Bateman Pumping Station is operating slightly better and more effectively than was predicted in Memorandum No. 25. Chloride removal during the test period actually exceeded projections.
- * There appeared to be significant flushing of chloride from the alluvium in the intervening reach between Bateman and Benjamin during the high-flow period between May and June 1987 which resulted in high chloride loads passing Benjamin. After this initial flushout,

chloride loads at Benjamin during the low-flow period from September through April 1988 were less than the long-term average anticipated with the Bateman Pumping Plant in operation. As suggested in the design documents, high chloride loads can be expected during high flows in the early years of operation. But an analysis of the data suggests that the long-term average should approximate the anticipated load after the system approaches equilibrium with the Area VIII facilities in operation.

We believe our task has been completed and recommend that authorization be given to continue with the construction of the Red River Chloride Control Project. The Panel greatly appreciates the cooperation and assistance it has received from the Tulsa District, U.S. Army Corps of Engineers, Tulsa, Oklahoma, and the Texas District Office, U.S. Geological Survey. We feel that a note of thanks is in order for both of these units.

Sincerely,

A handwritten signature in cursive script, reading "Jack Keller". The signature is written in dark ink and is positioned above the typed name.

Dr. Jack Keller, Chairman

REPORT

on the

Evaluation of the effectiveness of
operation of Area VIII of the
Red River Chloride Control Project

Required by
PL 99-662

August 1988

PANEL

<u>Position</u>	<u>Member</u>	<u>Representing</u>
Chairman	Dr. Jack Keller	National Academy of Science
Vice Chairman	Mr. Jack Rawson	U. S. Geological Survey
Member	Dr. Herbert Grubb	State of Texas
Member	Mr. Jackson Kramer	Texas Water Commission
Member	Mr. Glenn Sullivan	State of Oklahoma

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DEFINITION OF SELECTED TERMS

Discharge (or Flow) is the volume of water that passes a given point within a given period of time.

Mean discharge is the arithmetic mean of individual daily mean discharges during a specific period.

Instantaneous discharge is the discharge at a particular instant of time.

Day-second/feet (DSF) is the volume of water passed in one day at a flow of one CFS.

Cubic foot per second (cfs) is the rate of discharge representing a volume of 1 cubic foot passing a given point during 1 second and is equivalent to 7.48 gallons per second, 448.8 gallons per minute, or 0.02832 cubic meters per second.

Discharge weighted average concentration approximates the composition of water, or the concentration of a constituent, that would be found in a reservoir containing all the water passing a given location in a given time after mixing in the reservoir. It is computed by multiplying the discharge for a sampling period by the concentration of individual ions constituents for the corresponding period and dividing the sum of the products by the sum of the discharges.

Tons/day is the quantity of a substance (tons) in solution or suspension that passes a stream section during a 24-hour period. It is calculated by multiplying the product of the daily mean discharge (cfs) and daily mean concentration (Mg/L) by 0.0027.

Dissolved refers to that material in a representative water sample which passes through a 0.45 micrometer membrane filter. Determinations of "dissolved" constituents are made on subsamples of the filtrate.

Milligrams per liter (Mg/L) is a unit for expressing the concentration of chemical constituents in solution and represents the mass of solute (milligrams) per unit volume (liter) of water.

Specific conductance is a measure of the ability of water to conduct an electrical current and is expressed in microsiemens per centimeter at 25°C. Specific conductance is related to the type and concentrations of ions in solution and can be used for approximating the concentrations of dissolved solids and major ions in the water. These relationships are not constant from stream to stream and even may vary for the same source with changes in the composition of the water.

Water Year Begins on October 1 of the preceding year and ends September 30 of the year of record, i.e. water year 1988 begin in October 1, 1987.

EXECUTIVE SUMMARY

EVALUATION OF THE EFFECTIVENESS OF OPERATION
OF AREA VIII OF THE RED RIVER
CHLORIDE CONTROL PROJECT

EXECUTIVE SUMMARY

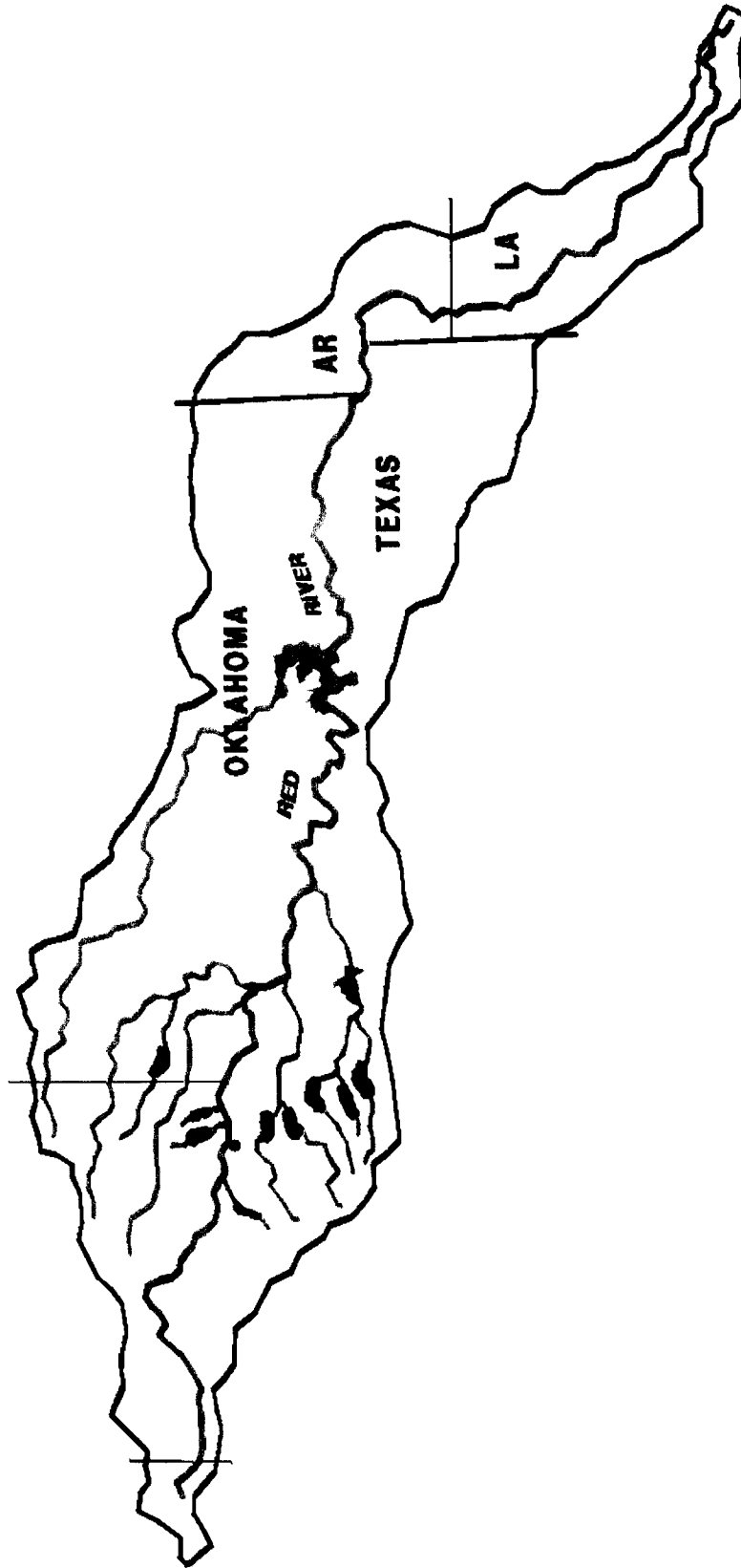
Approximately 3,600 tons of dissolved salt are carried into the Red River each day through natural salt sources located in the upper reaches of the river's drainage area. Of the ten identified natural salt sources, one is located in Oklahoma, and the remaining nine are in Texas. Salt springs along the river have rendered it, and Lake Texoma--which receives an annual average of 3.1 million acre-feet of water--virtually unusable as sources of water for irrigational, industrial, and municipal use. Water use over the Red River Basin (see Figure 1) varies from primarily agricultural irrigation in the upper reaches in Texas and Oklahoma to industrial in Arkansas and Louisiana. Municipal uses are widespread through the basin.

Projected population and industrial growth rates for the basin show that increasing demands for water will exhaust all present sources in the near future, thus requiring the use of Red River water. Currently, virtually all the good quality stream water within the region has been appropriated, thereby limiting further irrigation, municipal and industrial development. Some water for irrigation is presently being taken from the Red River and Lake Texoma. However, use of the poor quality water has reduced the average crop yield and lowered crop values along with damaging land and equipment. Existing industrial and municipal treatment facilities, piping systems, water heaters, and other household appliances are also being damaged by the high chloride level. Millions of acre-feet of groundwater in the shallow alluvium and terrace deposits along the Red River and its tributaries have been polluted due to interaction with stream flows. Control of salt springs in the upper reaches of the river and its tributaries would provide surface water for thousands of irrigable acres along the river and at the same time improve the quality of groundwater supplies. If contributing salt springs are controlled, the Red River could be made usable along its entire reach, thereby diminishing the need to develop other sources of supply.

This report details the evaluation of the operational effectiveness of Area VIII of the Red River Chloride Control Project (see Figure 2). The project's objective is to improve the quality of water in the river by removal of salt pollutants. Area VIII is located on the South Fork of the Wichita River and utilizes a collection and disposal concept designed to intercept and divert 85 percent of the estimated 195 average daily tons of chlorides entering the South Wichita River.

BACKGROUND

Studies to control natural salt pollution in the Arkansas and Red River Basins began in 1957 when Congress directed the U.S. Public Health Service to locate the major sources of natural salt pollution in those basins. In the Red River Basin (Upper Red River and Wichita River), the ten major sources located were identified as Areas V, VI, VII, VIII, IX, X, XI, XIII, XIV, and XV, and the U.S. Army Corps of Engineers was directed to determine the costs and benefits of alternative control plans. A survey report was completed in 1966 that recommended chloride control plans at the salt sources on the



RED RIVER BASIN

FIGURE 1

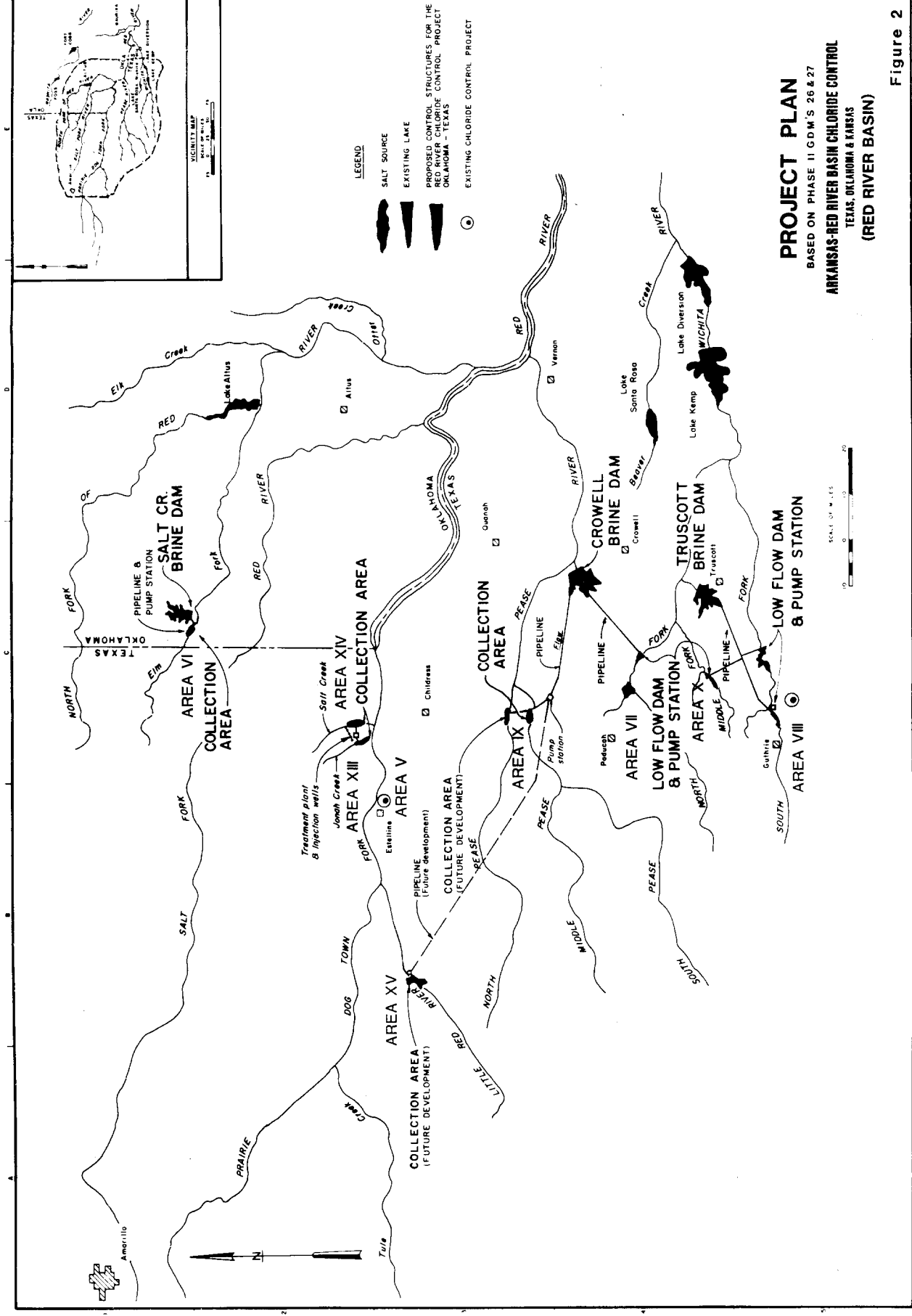


Figure 2

C

Wichita River portion which includes Areas VII, VIII, and X. In 1974, the Water Resources Development Act provided special authorization to construct control measures at Area VIII on the Wichita River. Construction of the Bateman Pump Station and Truscott Brine Lake was initiated in 1976. The Water Resources Development Act of 1986 (PL 99-662) amended the previous laws and authorized construction of the remaining elements of the Red River Basin project, subject to a favorable report by a review panel established to evaluate the effectiveness of operation of Area VIII of the Red River Chloride Control Project, and a finding of it being consistent with the project benefits projected in Memorandum No. 25, completed in November 1980. The panel consists of:

Dr. Jack Keller (Panel Chairman)
Department of Agricultural and
Irrigation Engineering
Utah State University

Mr. Jack Rawson (Panel Vice-Chairman)
Associate District Chief,
Texas District, Water Resources Division,
U.S. Geological Survey
Austin, Texas

Dr. Herbert Grubb
Director of Planning
Texas Water Development Board

Mr. Jackson H. Kramer
State/Federal Relations Coordinator
Texas Water Commission

Mr. Glenn Sullivan, Secretary
Department of Natural Resources
State of Oklahoma

PROJECT PLAN

Area VIII is on the South Fork of the Wichita River about 5 miles east of Guthrie near the center of King County, Texas, and is about 4 miles north of U.S. Highway 82. Almost 50 percent of the natural chlorides polluting Lake Kemp come from the springs and seeps of Area VIII. Four springs which emerge from cavernous openings in the gypsum cliffs on the north side of the river have combined flows of approximately two cubic feet per second. Area VIII produces an average daily chloride load of 195 tons.

The plan for Area VIII includes two low-flow collection dams which are required on the South Fork of the Wichita River to collect brine which is to be pumped to Truscott Brine Lake. One completed dam (Bateman), consists of a 5-foot high deflatable weir. The weir impounds a pool to facilitate pumping and deflates during periods of high flows. The Bateman Pump Station transports the brine via 23 miles of pipeline to Truscott Brine Lake for disposal. The second brine collection structure identified in the selected plan would be constructed only as and if needed, and would be located at

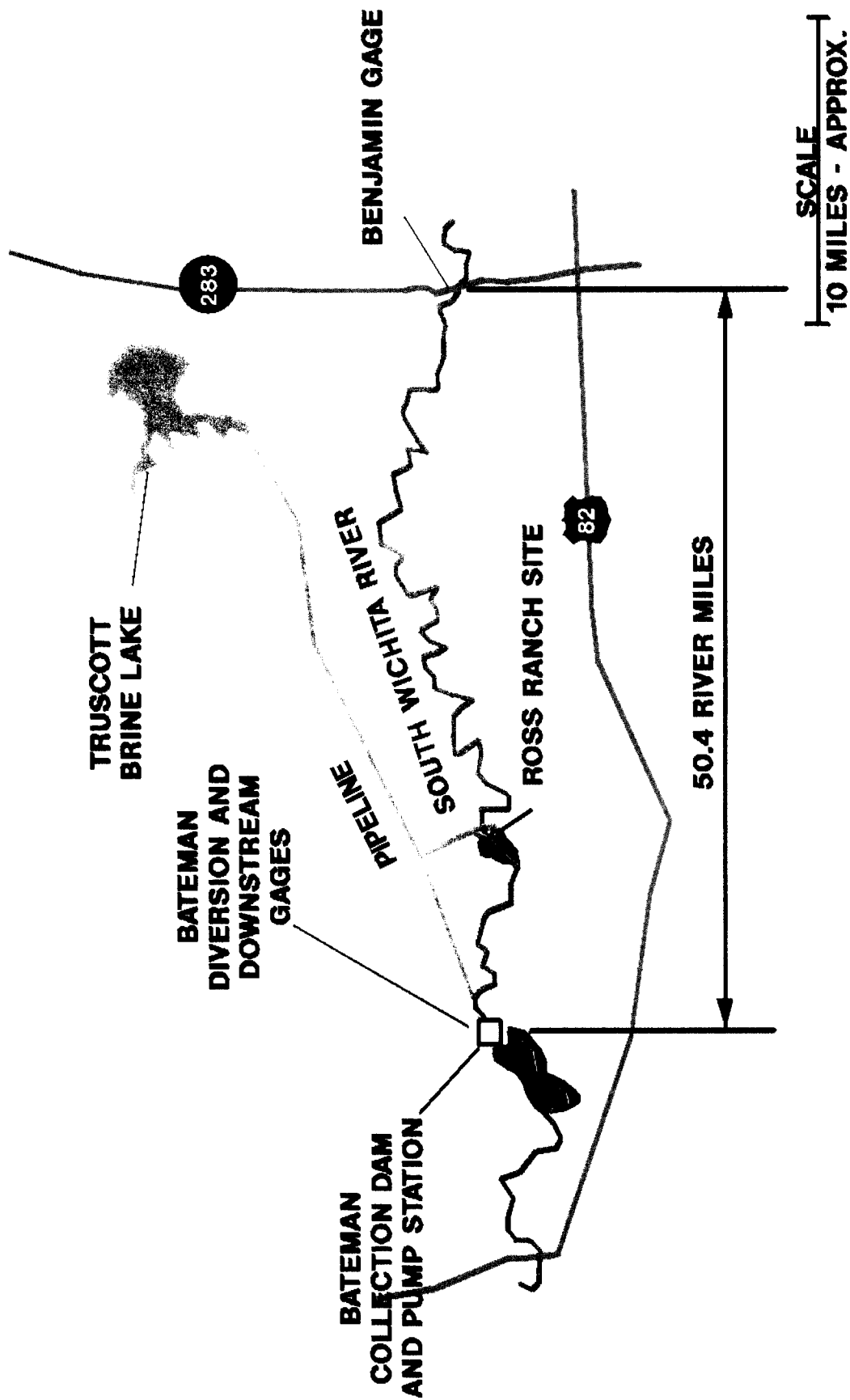
river mile 61.5 (Ross Ranch), with the diverted brine also being pumped to the Truscott Brine Lake.

A network of continuous-record streamflow and water quality stations on streams in the Red River basin has been operated for many years by the U.S. Geological Survey in cooperation with the U.S. Army Corps of Engineers and other Federal, state, and local agencies. Information on the location, drainage area, period of record, and types of instrumentation for stations applicable to the project are summarized in the report. The panel decided that a study of the data collected based on one year of operation of the Bateman Pump Station would be sufficient to adequately assess the effectiveness of its operation. This data quantifies the reduction of chlorides at both the Bateman and Benjamin gages. The records on which the project results are based are for the period from May 1, 1987, through April 30, 1988. Locations of the Bateman Pump Station and the downstream gaging stations are shown on Figure 3. The complete daily records of the quantity and quality of the water diverted and the flow at stations up and downstream from the low-flow dam and near Benjamin are included in the report (Table 1). Monthly summaries are also provided which detail the quantities of flow and the concentrations and loads of chloride in flows diverted by pumpage; the quantities of flow and concentrations and loads of chloride in such flow that passed downstream from the low-flow dam due to minor seepage under and around the dam, due to deflation of the dam during high flows and when breaks were being repaired in the pipeline (spillage); and the quantities of flow and concentrations and loads of chloride at the station near Benjamin. These data were deemed by the panel to be sufficient to allow proper evaluation of the Area VIII operation.

PROJECT RESULTS

A comparison of the records show that diversions of the more saline low flows resulted in an 86-percent reduction of the chloride load in the flow passing downstream from the Bateman Pump Station. This occurred even though an average of more than 138 tons/day of chloride was spilled during the test period when two pipeline breaks occurred reducing the effectiveness of the pumping effort, as well as record high flows in May and June 1987. However, high flow periods will occur from time to time throughout the life of such a project but on average should not constitute a very large portion of the time. Likewise, pipeline breaks will occur during the operational phase, but the total down-time is not expected to rise in future years and may even drop as experience in repairs is acquired. Projected chloride diversions based on the Bateman pumping operations were simulated on older data collected during water years 1971 through 1976. The simulation resulted in an even greater reduction of the chloride load than occurred during the one-year evaluation period.

The water quality records for both the Bateman and Benjamin stations are considered to be representative of the long-term prepumping conditions. During the one-year period, flows at Benjamin averaged 37 cubic feet per second and chloride loads averaged 153 tons/day. According to the Chloride Control Plan for Area VIII, pumpage of an averaged chloride load of 142 tons/day at Bateman would reduce the average chloride load at Benjamin to about 68 tons/day. However, pumpage of an average chloride load of 192 tons/day at Bateman during the one-year period reduced the average chloride



AREA VIII **RED RIVER CHLORIDE CONTROL PROJECT**

FIGURE 3

TABLE 1

WATER DISCHARGES AND CHLORIDE CONCENTRATIONS AND LOADS
FOR SELECTED SITES ON THE SOUTH WICHITA RIVER, TEXAS, MAY 1987 - APRIL 1988

Period	ABOVE BATEMAN			BATEMAN DIVERSIONS			SPILLED BELOW BATEMAN			BELOW BATEMAN NEAR BENJAMIN		
	Water discharge (cfs)	Dissolved chloride (Mg/L) (tons/day)	Water discharge (cfs)	Dissolved chloride (Mg/L) (tons/day)	Water discharge (cfs)	Dissolved chloride (Mg/L) (tons/day)	Water discharge (cfs)	Dissolved chloride (Mg/L) (tons/day)	Water discharge (cfs)	Dissolved chloride (Mg/L) (tons/day)	Water discharge (cfs)	Dissolved chloride (Mg/L) (tons/day)
May 1987	58.7	1,960	313	10,000	155	53	1,100	158	249	920	613	
June	14.0	5,890	220	6,100	180	3.0	5,100	40	108	1,700	500	
July	10.8	7,870	232	8,600	187	2.8	5,800	45	32	2,800	239	
August	7.86	10,000	218	10,000	197	.76	10,000	21	21	2,400	142	
September	7.86	10,000	218	10,000	217	.06	8,800	1.5	8.2	2,600	60	
October	6.96	11,000	201	11,000	200	.06	9,000	1.4	1.3	5,200	19	
November	7.35	11,000	214	11,000	213	.05	9,400	1.2	1.1	5,900	18	
December	7.96	10,000	220	10,000	145	.26	9,600	6.8	3.6	5,400	52	
January 1988	7.30	9,860	200	10,000	145	2.1	9,500	55	5.6	4,700	71	
February	7.45	11,000	218	11,000	214	.15	11,000	4.1	3.0	5,700	45	
March	7.45	11,000	224	11,000	223	.05	10,000	1.3	3.9	4,100	42	
April	6.21	11,000	187	11,000	163	.81	11,000	24	4.0	3,800	40	
May 1987- April 1988	12.5	6,520	222	9,770	192	5.25	2,100	30	37	1,550	153	
October 1970- September 1976	5.25	10,700	154									

load at Benjamin to only 153 tons/day. This discrepancy is readily explainable. As shown in Table 1, flows were exceptionally high during May, June, and July 1987 (May being the wettest month of record). In a way, this was a fortunate event in that it provided both high-flow and low-flow conditions for evaluation of the project's performance at Benjamin. Data indicate the much greater-than-average flows in May and June 1987 (the majority of which originated from flood runoff downstream of Bateman Pump Station) resulted in a significant flushing of chloride from the alluvium along the South Wichita River between Bateman Pump Station and Benjamin. After an initial flushout, dramatically lowered chloride loads accompanying low seasonal flows demonstrated the effectiveness of the Bateman Pump Station Operation.

FINDINGS OF THE PANEL

It is specifically noted and emphasized by the Panel that under the economic reanalysis contained in Memorandum No. 25, no benefits were credited to the project until all project elements of the areas recommended for construction were completed. Water quality benefits were only phased in as Red River water was actually used. The benefits were then allowed to grow as the use of the Red River water increased. The Panel would also observe that the economic reanalysis of 1980 was based upon appropriate concepts and reached appropriate conclusions. Therefore, any reanalysis of the benefits was not only outside the charge and authority of the evaluation Panel, but also impossible because benefits cannot begin accruing until such time as the water is used.

Upon review and evaluation of the data, the Panel concludes that the control system at the Bateman Pumping Station is operating better and more effectively than was predicted in Memorandum No. 25. Chloride removal during the test year actually exceeded projections and the expected level of control over the anticipated life of the project is estimated to be at least 87 percent, which again, exceeds projections.

PURPOSE

The purpose of this document is to present the findings of an effectiveness evaluation study on the operation of Area VIII (Bateman Pump Station portion) of the Red River Chloride Control Project by a five-member review Panel in accordance with paragraph C, Section 1107 of the Water Resources Development Act of 1986 (PL 99-662), 17 November 1986:

"(c) Construction of remaining elements of the project involving the Red River Basin shall be initiated in accordance with the recommendations regarding general design memorandum numbered 25 by the director of civil works on behalf of the Chief of Engineers, dated August 8, 1977. Such construction shall commence upon transmittal of a report to the Secretary and to the Committee on Environment and Public Works of the Senate and the Committee on Public Works and Transportation of the House of Representatives of a favorable finding on the effectiveness of the operation of area VIII, to be made by a Panel consisting of representatives of the United States Geological Survey and the Texas Water Commission, a person selected by the National Academy of Sciences, and two other qualified persons to be appointed by the Secretary with the concurrence of the Governors of Texas and Oklahoma. The Panel shall assess the improvement in water quality downstream of area VIII to determine its consistency with the water quality assumed in the development of project benefits in the economic reanalysis of the project completed in November 1980. Such report shall be submitted to the Secretary and to such committees no later than three years after the date area VIII commences operation. Cost sharing for construction on the Red River Basin project initiated under this section shall be the same as the cost sharing for Area VIII of the project."

PART I

Background Information

HISTORY OF THE CHLORIDE CONTROL STUDIES

The Red River Basin covers nearly 94,000 square miles in the five state area of New Mexico, Oklahoma, Texas, Arkansas, and Louisiana in the south-central United States. Runoff from this area represents a major national and regional water resource. However, this resource is unsuitable for most beneficial uses because of poor water quality. The primary pollutants are chloride salts, principally from natural sources. The effects of this pollution are widespread, severely limiting the use of the stream for municipal, industrial, and agricultural water supply. Studies to control the natural salt pollution were begun in 1957 when Congress directed the U.S. Public Health Service to locate the major sources. Ten major source areas were identified.

PRIOR REPORTS AND STUDIES

In 1959, Congress directed the Corps of Engineers to determine the costs and benefits of alternative control plans. The U.S. Army Corps of Engineers has developed a plan to control the natural salt pollution at the source areas. The authorized Chloride Control project will eliminate 69 percent of the natural chloride pollution resulting in substantial improvements in the total dissolved solids and chloride concentrations of the basin's waters.

Experimental work at Estelline Springs, Texas (Area V), in the Upper Red River Basin, was authorized in 1962, and an effective control plan was completed two years later. A survey report completed in 1966 recommended Chloride Control plans at the salt sources on the Wichita River portion (Part I) which include Areas VII, VIII, and X. Part I was authorized by Congress in 1966, and preconstruction planning was initiated in 1968. The remaining areas in the Red River Basin (Part II) were the subject of a second survey report completed in 1966 which recommended Chloride Control plans at five of the remaining six salt source areas. Area XI was not recommended for further studies. Part II was authorized for construction in 1970. Detailed studies for the three areas in the Wichita River Basin were completed in 1972. In 1974, the Water Resources Development Act provided special authorization to construct control measures at Area VIII on the Wichita River. Construction at Area VIII was begun in 1977.

In 1976, General Design Memorandum No. 25 was submitted recommending control measures for the Wichita and Red River areas. Area XV and the North Pease River portion of Area IX were not considered economically feasible at that time and were recommended for future consideration. In 1978, the Chief of Engineers requested an economic reanalysis of the entire Red River Chloride Control plan to include a significantly more detailed benefit analysis. The economic reanalysis was completed in 1980. Subsequent engineering and design studies have continued to further refine the project plan. The further refinement of the project was made in General Design Memorandum Nos. 26 and 27 completed in 1978 and 1982, respectively.

AUTHORIZING LAWS

The Chief of Engineers recommended Part I of the Arkansas-Red River Basin Water Quality Control Study for Areas VII, VIII, and X, Wichita River, Red River Basin, in Senate document No. 110, 89th Congress, 2nd session. The

Flood Control Act of 1966 (PL 89-789, November 7, 1966) incorporated Senate Document No. 110 by reference and authorized Part I. Actual construction was not to be initiated until Part II was authorized. The Flood Control Act of 1970 (PL 91-611, 31 December 1970) amended the 1966 Act and authorized Part II of the study for Areas VI, IX, XIII, XIV, and XV in the Red River Basin. Construction was not to be initiated until approved by the Secretary of the Army and the President. Part II of the study was recommended by the Chief of Engineers in his report dated May 6, 1970. The Water Resource Development Act of 1974 (PL 93-251, March 7, 1974), specifically authorized construction of Area VIII without the approval of the Secretary of the Army and the President. The Water Resources Development Act of 1976 (PL 94-587, October 22, 1976) amended the Flood Control Act of 1970 thus eliminating the required approval of the President.

The Water Resources Development Act of 1986 (PL 99-662) amended the previous laws and authorized construction of the remaining elements of the Red River Basin project, subject to a report of favorable findings by a review Panel regarding the effectiveness of the operation of Area VIII.

SOURCES AND PROBLEMS

SOURCE OF CONTAMINATION

During the Permian Period, about 230 million years ago, much of the Texas panhandle, southeastern New Mexico, western Oklahoma, and southern Kansas was covered by a shallow inland sea. Over time evaporation precipitated salts in the sea water leaving thick deposits of halite which are currently present in geologic formation underlying the area. Natural chlorides from ten major salt source areas in the Red River Basin contribute about two-thirds of the average daily load of 3,300 tons/day of chlorides entering the river. The process by which this occurs is as follows: fresh groundwater migrates downward and laterally to the salt beds, which are 15 to 120 meters below the surface, dissolving the salt to produce brine. The brine is then forced laterally and upward by hydrostatic pressure through aquifers or through joints, fractures, and solution channels until emitted at the surface. In some areas the brine is emitted as a flowing spring. In others, it is emitted from seeps along the stream bed and becomes part of the surface waters. Contaminants further degrade the surface flows when capillary action causes surface encrustations (salt flats). The locations of the ten major salt sources in the Red River Basin are shown in Figure 1. Loads from these areas vary from 48 tons of chloride per day at Area X in Texas to over 510 tons of chlorides per day at Area VI in Oklahoma (see Table 2).

EFFECTS OF CONTAMINATION

Natural pollution renders the Red River generally unsuitable as a dependable source of irrigation and municipal and industrial water supply. In the western part of the basin, agricultural potential is severely restricted since thousands of acres of irrigable land cannot be irrigated from the river, or can only be irrigated to a limited extent. Because of high salinity, municipalities and industries in the benefitted areas (Arkansas, Louisiana, Oklahoma, and Texas) will suffer damages to pipes, equipment, and household appliances and possibly suffer adverse health affects from use of untreated water, pay the high cost of elaborate treatment

TABLE 2

LOCATION AND CHLORIDE LOADS OF RED RIVER SALT SOURCE AREAS

Area	Location	Receiving Stream	Chloride Load (ton/day)
V	Hall County, TX	Prairie Dog Town Fork of Red River	300 ^a
VI	Harmon County, OK	Elm Fork of North Fork Red River	510
VII	Cottle County, TX	North Fork of Wichita River	186
VIII	King County, TX	South Wichita River	195 ^b
IX	Cottle County, TX	North and Middle Pease River	342
X	King County, TX	Middle Fork of Wichita River	48
XI	Briscoe & Armstrong	Prairie Dog Town Fork of Red River	220
XIII	Childress County, TX	Jonah Creek - Tributary of Prairie Dog Town Fork of Red River	420
XIV	Childress County, TX	Salt Creek - Tributary of Prairie Dog Town Fork of Red River	150
XV	Hall County, TX	Little Red River - Tributary of Prairie Dog Town Fork of Red River	120

^aRing dike operational since 1964.

^bSum of calculated loads at Bateman and Ross Ranch.

processes to reduce the salinity, or obtain fresher supply sources from greater distances to fulfill their demands for water. In some cases, the water can and is being used by withdrawing water during high flows when the chloride concentrations are diluted. This manner of usage requires large offstream storage to supply needs during prolonged low-flow periods. The water can also be used for municipal and industrial purposes by diverting flows and mixing with fresher water sources. However, this method likewise limits the quantities which can be used because mixing ratios must be carefully monitored to maintain acceptable and consistent water quality.

The large quantities of water in the Red River that could be available for water supply have not been fully used because of the natural salt pollution. If this salinity problem were reduced or eliminated, much greater use could be made of existing water supplies, and the need to construct

additional reservoirs and to mine limited ground water supplies would be diminished.

SELECTED PLAN

The selected plan for the salt emission areas authorized for construction is presented in this section. An existing ring dike at Area V is to be operated as constructed. No technically feasible control plan was developed for Area XI. The control plans for Area XV and the North Pease River portion of Area IX, although technically feasible, were not economically justified and were recommended for future consideration. The selected plan includes Areas VI, VII, VIII, IX (Middle Pease River only), X, XIII, and XIV and three brine lakes (Salt Creek, Crowell, and Truscott). The overall plan is illustrated in Figure 2. Descriptions of the various elements of the Chloride Control project follow.

AREA V

Estelline Springs is approximately 1 mile east of Estelline, Texas, near the Hall-Childress County line (Figure 2). The spring is in the flood plain of the Prairie Dog Town Fork of the Red River at about river mile 1,073. Salt water in this area is brought to the surface through the one large spring and several small seeps. Under natural conditions the average rate is about 4 cubic feet per second (cfs) and contributes 300 tons of chlorides per day to Mountain Creek, a tributary of the Prairie Dog Town Fork. An experimental project was constructed at the spring to test the application of backhead as a means of suppressing individual brine springs. The structure around the springs is a circular earthen dike 9 feet high and 340 feet in diameter with an impervious core to firm rock. In January 1964, the spring flow was completely suppressed by an average 5 feet of backhead. The spring has since maintained a reasonably constant level and the ring dike contains about 80 percent of the total chloride load emitted from Area V. The experimental status of the structure has been changed to an operational status as a permanent control installation.

AREA VI

The Area VI plan includes brine collection on the Elm Fork of the Red River and disposal in the Salt Creek Brine Lake (Figure 2). In the plan, collection of brine on the Elm Fork is accomplished by construction of a 115-acre brine detention reservoir. A dam across the Elm Fork encloses the upstream and downstream limits of the emission area, the present Elm Fork channel and adjacent flood plain through the south bank emission zone. Diversion of the Elm Fork at a point above the detention site is accomplished by a 200-foot bottom width channel excavated in the flood plain north of the present Elm Fork channel. From the collection facilities, the brine is pumped to the Salt Creek Brine Lake through a 4-mile pipeline. The Salt Creek Brine Lake dam is a 4,500-foot earthen embankment. The lake has a surface area of 735 acres at the top of the brine storage pool. The total controlled storage is 33,430 acre-feet for control of the 100-year frequency storm and for 100 years accumulation of brine and sediment.

AREA VII

In the plan for Area VII, brine is collected on the North Fork of the Wichita River by a low flow dam at river mile 213 and stored in Crowell Brine Lake (Figure 2). The low flow dam has a five-foot high deflatable weir that extends across the existing stream channel. The weir impounds a minimum pool to facilitate pumping and deflates to eliminate a channel restriction during high flow periods. The chloride concentration during flood conditions is too low to justify collection. Pumps and pipeline are used to transport the brine to Crowell Brine Lake. Crowell Brine Lake is located in Ford County at mile 1.6 on Canal Creek, a Pease River tributary. This lake is the disposal facility for Area VII. Storage for brine from Area IX is also be provided. The brine storage dam consists of an earthen embankment and the lake has a surface area of 3,820 acres at the top of the brine storage pool and 4,190 acres at the top of the flood control pool. The total controlled storage is 191,000 acre-feet for control of the 100-year frequency storm and 100-year accumulation of brine pumped from Areas VII and IX, and for future development at Areas IX and XV.

AREA VIII

The plan for Area VIII includes two low flow collection dams which are required on the South Fork of the Wichita River to collect brine which is be pumped to Truscott Brine Lake (Figure 2). One dam, already completed at river mile 74.9, consists of a 5-foot high deflatable weir. The weir across the existing stream channel impounds a pool to facilitate pumping and deflates during periods of high stream flow. The brine is transported by a pumping facility (Bateman Pump Station) and pipeline to Truscott Brine Lake. If needed, the second brine collection structure will be located at river mile 61.5. The need will be determined after operation of the upstream collection facility. Pumping facilities (Ross Pump Station) will be built to pump the brine through a pipeline to Truscott Brine Lake for disposal. Truscott Brine Lake is at mile 3.6 on Bluff Creek, a south bank tributary of the North Fork of the Wichita River. The earthfill embankment has a maximum height of 100 feet above the streambed and a total length of about 14,800 feet. The lake has a surface area of 2,980 acres at the top of the brine storage pool and 3,090 acres at the top of the flood control pool. The total controlled storage is 116,200 acre-feet for control of the 100-year frequency storm and 100 years accumulation of brine and sediment. Truscott Brine Lake is designed to contain brine flows from collection facilities at Areas VIII and X.

AREA IX

The Area IX plan consists of a surface collection system and a pipeline system, with disposal at Crowell Brine Lake (Figure 2). The plan is to collect flows up to a maximum of 20 cfs from the Middle Pease River, which contains 190 tons/day of chlorides. The collection structure consists of a reinforced concrete structure with a fiberglass grate. The water is diverted over the collection structure by an overflow and training dike. A 200-acre-foot storage pond is provided to minimize pipeline size. The proposed storage pond has an average area of 49 acres and a maximum depth of 7-feet. The collection system for the North Pease is recommended for future consideration.

AREA X

The Area X plan consists of a low flow dam which collects brine on the Middle Fork of the Wichita River at mile 20.5 (Figure 2). The low flow dam is similar to that described for Area VIII. The brine is pumped to Truscott Brine Lake (discussed in detail with Area VIII).

AREAS XIII AND XIV

The plan for Areas XIII and XIV consists of a subsurface collection and pipeline system, water treatment, and subsurface disposal (Figure 2). Area XIII has three large-diameter wells and Area XIV has two large-diameter wells drilled into the brine aquifer. The wells are about 25 feet deep. The raw brines from the collection wells are transported through pipelines to a treatment plant and then to injection wells for disposal. The injection wells are drilled into the Ellenburger formation about 5,800 feet below the surface. Five injection wells are required for both Areas XIII and XIV.

AREA XV

The Chloride Control plan for Area XV was not economically feasible and is recommended for future development. The collection facility considered consisted of a subsurface cutoff wall combined with a shallow well system. Three separate collection areas are used: Bluff Creek, Lost Mule Creek, and the main stem of the Little Red River. The subsurface cutoff walls are located at the mouths of Bluff and Lost Mule Creeks and upstream from the Highway 70 bridge. The system design is similar to that discussed for Area VI. The shallow well system is located upstream from the subsurface cutoff wall and is of the same design as proposed for Area IX. Brine from both the subsurface cutoff and the shallow well system would be pumped through a pipeline system for that area to Crowell Brine Lake for disposal. Crowell Brine Lake was discussed in the plan of improvement for Area VII.

PLAN EFFECTIVENESS

The objective of the Chloride Control project is to provide the most practical means of improving the quality of water in the Red River Basin for beneficial uses. It is estimated that the selected plan will be very effective in accomplishing the objective. The natural chloride loadings and the expected effectiveness are presented in Table 3 for each salt source area. Table 3 is quoted from "Supplemental Data to Arkansas - Red Basin Chloride Control, Red River Basin, Design Memorandum No. 25, General Design, Phase I - Plan Formulation," Vol. 1, Department of the Army, Tulsa District, Corps of Engineers, Tulsa, Oklahoma, November 1980; page II-16.

TABLE 3

ANTICIPATED CHLORIDE CONTROL PLAN ACCOMPLISHMENTS ACCORDING TO DESIGN

Salt Source Area	Estimated Average	Estimated	
	Natural Chloride Load (tons/day)	Chlorides Controlled (tons/day)	(Percent)
V	300	240	80 ^a
VI	510	420	82
VII	186	157	84
VIII	195 ^b	165	85
IX	342	190	60
X	48	40	84
XI	220	-	-
XIII	420	370	88
XIV	150	130	87
XV	120	-	-
Total Identified			
Natural Source	2,491	1,712	69

^aRing dike operational since January 1964

^bSum of calculated loads at Bateman and Ross Ranch.

Source: Design Memorandum No. 25, Vol. 1, Department of the Army, Tulsa District, Corps of Engineers, Tulsa, Oklahoma, November, 1980; Page II-16

CURRENT STATUS

Preconstruction planning for the Red River Chloride Control Project is complete. Plans and specifications have been completed for portions of Areas VII and X which would allow construction to be initiated when funds become available. Plans could be completed quickly for a portion of Area VI so that construction could also be initiated when funds become available.

As previously stated, Area VIII and Truscott Brine Lake were authorized for construction in March 1974. Construction of the Bateman Pump Station and Truscott Brine Lake was initiated in 1976 and the project was essentially complete and declared operational in May 1987.

EVALUATION PANEL HISTORY

In accordance with PL 99-662 an evaluation study Panel was established to evaluate the effectiveness of operation of Area VIII of the Red River Chloride Control Project. The Panel consists of:

Dr. Jack Keller (Panel Chairman)
Professor, Department of Agricultural and
Irrigation Engineering
Utah State University
Logan, Utah

Mr. Jack Rawson (Panel Vice-Chairman)
Associate District Chief,
Texas District, Water Resources Division,
U.S. Geological Survey
Austin, Texas

Dr. Herbert Grubb
Director of Planning
Texas Water Development Board
Austin, Texas

Mr. Jackson H. Kramer
State/Federal Relations Coordinator
Texas Water Commission
Austin, Texas

Mr. Glenn Sullivan
Secretary of Natural Resources
State of Oklahoma
Oklahoma City, Oklahoma

The first meeting of the evaluation Panel was held in Wichita Falls, Texas, on 23 October 1987. The purposes of this meeting were to officially convene the Panel, to brief the Panel on the background and objectives of the entire project, and update members on the status of Area VIII and the data collection program being conducted by the United States Geological Survey (USGS). This was accomplished by a series of presentations by the Tulsa District, U.S. Army Corps of Engineers, and the USGS, and aerial reconnaissance and field visit to Bateman Pump Station and Truscott Brine Lake. The following quotations from the minutes express the important decisions of the meeting:

"4. ...It was generally concluded upon by all present that the data currently being collected at the Bateman gages (located upstream and downstream of the Bateman Pump Station) and the Benjamin gage (located on the South Fork of the Wichita River, approximately 50 river miles downstream of Bateman) were all that could be effectively used and that this data should be sufficient to allow proper evaluation of the effects of Area VIII operation. This data is to be used to show the reduction of chlorides in tons/day and mg/l at both the Bateman and Benjamin gages."

The Panel requested the Corps to assemble the following information for the follow-up meeting:

"a. A correlation of the data collected at the Bateman and Benjamin gages to allow:

(1) Synthetic development of stream flows and loads for periods when records are not available.

(2) Determination of the predictability of stream flow and loads.

- b. The expectations and assumptions made by the Corps of the response of the South Fork of the Wichita River at the Benjamin gage in terms of chloride loads and concentrations used in cleanup evaluations and benefit analysis.
- c. Physical sample data for the alluvial and stream flows for the South Fork and its tributaries above the Benjamin gage.
- d. Any alluvial geotechnical data available in the reach between the Bateman and Benjamin gages."

At the November 30 meeting data requested were assembled by the Corps and reviewed by the Panel and the following decisions, as quoted from the minutes, were reached.

"11. Discussion followed on the probability and mechanism for flushing out the brines stored in the alluvial pore water between Bateman and Benjamin. It was concluded that due to the nature of the fine-grained alluvium, unless some major event occurred which could cause a mixing of pore water for the full depth of the alluvium (on the average of 20 feet), these brines would remain in place for the entire life of the project without causing any detrimental effects. The Panel agreed that no additional geotechnical analysis need be made.

"12. Mr. Bob Brown then made a presentation concerning project benefits as presented in the November 1980 report and the economists expectations concerning the water quality passing the Benjamin gage. The Panel agreed and restated their positions from the initial meeting that it would be outside the charge and authority of the evaluation Panel to attempt a reanalysis of the benefits.

"13. The Panel recognized that the period of (May - October 1987) for the operation of Bateman Pump Station represents an extreme wet period. This produced a higher concentration-duration curve than the long term average concentration-duration curve projected in the November 1980 report for the modified conditions. Therefore, the Panel recommended that collection be continued in order to make a better comparison between actual modified conditions and those projected in the November 1980 report.

"14. After considerable discussion concerning the data presented, the Panel decided that they would like to see some comparisons made using mass curves and the data from the historical period of record, the forecast collectable flows and loads, and the actual measurements from the period of operation. Using the historical data available for the Benjamin gage, the Corps was instructed to develop a single mass curve, plotting volume (in ac-ft) versus time. Then using the same type of curve for the period of time representing one year before pumping (May 1986 through April 1987) to the present time, the Corps is to find a "best fit" match with the historical mass curve to designate a period of time that will be used to judge the results at the Benjamin gage.

"15. Mass curves, plotting load of chlorides (tons) versus time will be developed and compared for the historical data and the data from one year before pumping to the present. The deviation of these two curves should provide a reasonable indication of the amount of tonnage removed by the operation of the Bateman Pump Station. An example of these curves is attached.

"16. The Panel also requested that another set of curves be developed. These curves will be in the form of the "scatter diagrams" presented by Mr. Fly. The period of record from 1971 through 1976 is representative of the entire historical period of record available for the Benjamin gage, and there is also data for the Bateman gage. This historical data will then be used to develop a forecast diagram (assuming the Bateman pumping station was in operation) to be compared with data collected during the actual (current) period of operation. An example of such a curve is attached."

At the meeting of February 18, the following decisions (quoted from the minutes) follows:

"5. Dr. Keller inquired as to the time the Corps expects benefits to start being realized from the project and asked what our time scale was for the system to stabilize, as included in the 1980 report.

Mr. Jim Sullivan indicated that no benefits were to be counted until all proposed elements of the project became operational. In the 1980 report, the economic analysis was based on starting the benefit flow upon the completion of the entire works in 1990. At this time, the start of construction of the remaining project elements is indeterminate until Congress appropriates construction funding for that purpose. With continued funding, construction of the remaining project could be complete in about 10 years.

"6. Dr. Keller then opened for discussion the Memorandum for Record of the 30 November 1987 - 1 December 1987 meeting of the Panel. It was determined that Item 11 on page 3 of the Memorandum for Record dated 2 December 1988 should be revised to say, "We agree, in a sense, that no additional geotechnical analysis is needed. We feel that in view of the data, that there may be considerable brine coming from the leachate between Bateman and Benjamin." The second sentence of paragraph 13 should be changed to read, "This produced a concentration-duration curve which is not comparable to the long term average concentration-duration curve projected in the November 1980 report for the modified conditions..."

"7. A general discussion of the data presented, followed. The attempt to compare the recent data at Bateman and Benjamin with the historical data at these gages over the period 1971-1976 did not appear to provide better insight into understanding the effects of diversion at the Bateman pump station. There were, however, windows of time in the prediversion data recorded for Bateman and Benjamin that seemed to compare with Data from both stations after Area VIII was placed in operation in May 1987. There were two periods of a

rather high flush of water and taper off of the flow in the period of time beginning October 1, 1986, on into the 1988 water year.

Mr. Fly was asked to provide a mass curve, scatter diagram and double mass curve analysis of the data during these periods of time by laying one plot on top of the other. A search should be made to find other periods of time that compare; these time periods should have similar flows at Bateman and Benjamin, and similar previous history and conditions both prior to and after beginning operation of the Bateman pump station. The mass curves, double mass curves and scatter diagrams desired for each window of time found comparable will contain four sets of points all starting from the same origin..."

During the course of the meetings it was decided by the evaluation Panel that a study of the data collected based on one year of operation of Bateman Pump Station would be sufficient to adequately assess the effectiveness of its operation.

PART II

Area VIII Chloride Control Project

DESCRIPTION OF AREA VIII

Area VIII is located on the South Wichita River about 5 miles east of Guthrie, Texas, near the center of King County, Texas; and is about 4 miles north of the U.S. Highway 82. The terrain is typical for the area with steep valleys and rugged gypsum hills. Six separate springs in this area produce an average daily chloride load of 195 tons/day at approximately 2 cfs.

The selected plan for Area VIII calls for two low-flow collection dams on the South Wichita River. One dam (Bateman Dam), already completed at river mile 74.9, consists of a 5-foot high deflatable weir. The weir across the existing stream channel impounds a pool to facilitate pumping and deflates during periods of high flows. The brine is transported by the Bateman Pump Station via 23 miles of pipeline to Truscott Brine Lake for disposal. Truscott Brine Lake has an earthfill dam located at mile 3.6 on the Bluff Creek tributary to the North Wichita River. The lake has 116,200 acre-feet storage capacity. The second brine collection structure, if needed, would be located at river mile 61.5. According to design plans a pumphouse (Ross Pump Station) will be built to pump brine to Truscott Brine Lake, if warranted. The data used in the study by the panel was taken at three USGS gaging stations on the South Wichita River. One is located at Bateman immediately above the dam (Bateman Gage #07311782), one immediately downstream (Bateman Gage #0731183), and an additional gage 50.4 river miles downstream at the Highway 283 bridge (Benjamin Gage #07311800).

GEOHYDROLOGY

ORIGIN OF BRINES

During Permian time, the Texas Panhandle and western Oklahoma were in the central part of a broad shallow sea that covered much of the southwestern United States. Because of slow but continual sinking in the earth's crust beneath all parts of this inland sea, a thick sequence of red beds and evaporites (dolomite, gypsum, and salt) were deposited north of the major reefs and other carbonate deposits of West Texas.

Normal marine water entered basins in West Texas from the open ocean to the southwest, and after passing over the reefs it entered the shallow inland sea where evaporation of the water took place. Fresh water from land areas on the east and west mixed with the marine and saline waters; typically, sediments were deposited in the alluvial and near-shore environments, whereas the evaporites were deposited in the more central part of the inland sea, or the deeper part of the three major basins.

Permian shales, siltstones, and sandstones deposited in the region were derived by erosion of land areas on the east and west sides of the inland sea. Land areas on the east side of the sea included much of central and eastern Texas, eastern Oklahoma, and eastern Kansas; the principal source areas for sediments were probably the Texas and Oklahoma portions of the Ouachita Mountain chain and the northeastern Oklahoma and eastern Kansas portions of the broadly uplifted Ozark region.

Permian evaporites in the study region formed primarily as a result of evaporation of sea water. The concentration of dissolved solids in sea water was raised by evaporation until a series of "evaporite" rocks was precipitated on the sea floor. The typical cycle of evaporite precipitation from sea water begins with deposition of a carbonate (limestone or dolomite), followed by deposition of gypsum or anhydrite, and finally by deposition of salt (halite, NaCl).

GEOLOGY AND BRINE EMISSION ON THE SOUTH WICHITA RIVER

The South Wichita heads up in King County just west of Guthrie in the Whitehorse formation, then flows across a belt of Dog Creek shale to the source area where the river has cut through the Dog Creek shale exposing the Blaine formation at river level. Here the six major springs that contribute to the brine pollution are encountered, just upstream and downstream of the Bateman Ranch low-water crossing. These springs emit from the gypsums and dolomite of the Blaine formation. Several artesian aquifers, generally dolomites of the Blaine Elm Fork group, contribute to the poor quality ground water. The river flows through the steep valley and rugged gypsum hills of the Blaine and Flowerpot formations to a point just west of the Knox County line where the valley walls become less steep in a narrow belt of San Angelo sandstone. As the river begins its course across the Choza shale just west of Highway 283, the valleys widen and relief is less pronounced until its confluence with the North Fork in the eastern extremity of Knox County.

Ground water emitting to the surface by springs in the source areas is responsible for the natural brine pollution in the Wichita River system. The brine is primarily a sodium chloride type but does have a high sulfate concentration also. Tests on brines from the subsurface show a range from 5,000 to 30,000 Mg/L chlorides, and from 2,500 to 4,000 Mg/L sulfates. An exception to this was encountered in hole 4 on the South Wichita River which tested 169,000 Mg/L chlorides.

Stratigraphy, local structure, and topography control the occurrences of the salt springs. Several artesian aquifers, generally dolomites, transmit the water from a distant point of unknown origin to the points of emission, usually in the proximity of local structure and favorable topographic conditions. Brine emission from the springs accounts for the majority of the flows and chloride loads in the rivers. The deeply weathered rocks in the river courses provide the opportunity for some of the artesian aquifers to lose the formation water to the zone of weathering. This allows for dilution and recirculation of those waters with local ground water from the adjacent karst topography and surface waters.

The ground water in the flood plain alluvium is similar to those recirculated waters which migrate through the alluvium. Stratigraphy of the areas consists primarily of Permian shales and evaporites below the Whitehorse group and including the Dog Creek shale, the Blaine formation, the Flowerpot shale, the San Angelo sandstone, and the Choza formation. Total thickness of these formations is about 1,000 feet, with about 600 feet of the section represented by the Dog Creek shale, Blaine formation, and Flowerpot shale.

The principal artesian aquifers are found in the eight major dolomites of the Dog Creek shale and Blaine formation. These aquifers may be regional in extent since these beds occur over a great lateral extent and since preliminary studies in other areas in West Texas and Oklahoma indicate the same general phenomena along this belt. The origin of the brines is still problematical, but the pervious sandstones at the base of the Whitehorse group combined with sinks, dune sand, and alluvial pockets to the west of the Dog Creek-Blaine outcrop belt could serve as a topographically high catchment basin. The meteoric waters could then percolate downward through joints and fractures in the rock strata, eventually reaching a stratum or strata offering lateral transmissibility. Depending on the occurrence of halite, the water would take the salt into solution and due to the hydrostatic conditions the brine would then be forced laterally in the strata to its emergence in outcrop or to the deeply weathered subsurface zone. Since the investigations have been limited to the deeply weathered emission areas, no conclusive statements can be made as to the origin, other aquifer characteristics, or distinctions made between the aquifers in the deep subsurface.

In the source area, the principal springs emit from an interval below the Mangum dolomite in the upper Elm Fork group of the Blaine formation. Three principal aquifers are subsurface at this point, the Creta, Jester, and Gypsum Creek. Apparently most of these aquifers lose their flows to the weathered rock prior to outcropping farther downstream. No significant points of brine emission were noted downstream of the outcrop patterns of the dolomite, but alluvium sampling and the gage at Benjamin near Highway 263 shows some increase in total load, possibly from the Flowerpot-San Angelo belts.

In contrast to the ground water conditions in the Dog Creek-Blaine belt are the water table aquifers of the San Angelo and Choza formations. These formations are both relatively tight, and of the two, the Choza is the most impermeable. Therefore, where location and conditions allowed, this formation was exploited for pumping locations and reservoir siting. A few wells and wind mills in the area are developed in the San Angelo sandstone but are usually of low yield. Several seeps or low volume springs occur occasionally in the San Angelo. The quality varies from 100 to 3,000 Mg/L, but is generally considered of low quality even though isolated occurrences provide water for stock.

OPERATIONAL GUIDELINES FOR BATEMAN PUMP STATION

Truscott Brine Lake, Areas VIII and X, and the associated pipelines were designed for a fully automated operation. The three pumps at Bateman Pump Station of Area VIII were sized to pump an average of 5 cfs each for a total of 15 cfs needed to control the projected goal of removal of 85 percent of the chlorides. Switchgear has been installed which will automatically increase the pumping capacity from one pump to two and/or three pumps as the water level rises behind the inflatable weir in the river. When the water level rises to a height of 6 inches above the inflatable dam, the pump station will automatically shut down and the dam will deflate. Pumping is resumed after a visual inspection of the facilities has been conducted and the dam has been reinflated. A decreasing water level will cause a decreased pumping capacity in a reverse order. The pipeline and associated controls

were designed to carry the collected brines from Area VIII (both Bateman and Ross Pump Stations) as well as Area X. During the start-up of the Bateman Pump Station it became apparent that the design of the flow control valves located at the outfall of the pipeline would not allow efficient, automatic operation of these facilities as initially designed. To achieve this automated operation, a new control valve configuration was designed and is scheduled to be installed by August 1988. During the redesign and installation, Bateman Pump Station and the outflow control valves were calibrated to run automatically in only a two-pump mode. It was also discovered during the start-up period that the combined efficiencies of the pumps and pipeline are such that a one-pump operation will produce an average flow of 7 cfs while a two-pump operation will produce an average flow of 14 cfs and three pumps an average of 18 cfs. It will be shown later in that data that the two-pump average of 14 cfs collected 86 percent of the chlorides during the first year of operation. Upon delivery and installation of the new flow control valves at the pipeline outfall, the pump station and associated pipeline controls will be recalibrated to allow for a fully automated, three-pump operation.

DATA COLLECTION PROGRAM

NETWORK

A network of continuous-record streamflow and water-quality stations on streams in the Red River basin has been operated for many years by the U.S. Geological Survey in cooperation with the U.S. Army Corps of Engineers and other Federal, State, and local agencies. Several of the stations are located in the drainage area of the South Wichita River (Area VIII of the Red River Chloride Control Project). Information on the location, drainage area, period of record, and types of instrumentation for stations applicable to this investigation are summarized in Table 4. Methods of data collection and computation of records by the Geological Survey are explained in a subsequent section. For an explanation of terms used in the following table and in the discussion of data collection and computation, the reader is referred to the section "Definition of Terms."

WATER-DISCHARGE RECORDS

Data obtained at a continuous-record streamflow station consist of a continuous record of water stage, individual measurements of water discharge throughout a range in stage, and notations regarding factors that may affect the relationship between stage and discharge. These data, supplemented by other information such as weather records, are used to compute daily discharge.

Continuous records of stage are obtained with analog or digital recorders. Instantaneous measurements of discharge are made with current meters by using methods adopted by the Geological Survey as a result of experience accumulated since 1880. In computing discharge records, stage-discharge relation curves are constructed by plotting results of individual discharge measurements against corresponding stages. These curves are then used to prepare rating tables that indicate the approximate discharge for any stage within the range of discharges measured. For extremes of discharge outside the range of current-meter measurements, the stage-discharge relation

TABLE 4
SUMMARY OF U.S. GEOLOGICAL SURVEY'S CONTINUOUS-RECORD STREAMFLOW AND
WATER-QUALITY PROGRAMS FOR AREA VIII SOUTH WICHITA RIVER

U.S.G.S. Station and Number	Location	Drainage Area (sq. mi.)	Water-stage and water- quality instrumentation	Period of continuous water-discharge record	Period of daily or continuous water-quality record
South Wichita River near Guthrie, Texas (Bateman) #07311780 (discontinued)	Lat 33°27'29", long 100°13'04", King County, 60 ft upstream from ranch road, 3.9 mi upstream from Willow Creek, 6.1 mi east of Guthrie, and 92.5 mi upstream from mouth.	222	Water-stage recorder Specific conductance recorder	1952-54, Oct 70 Sep 76 (discon)	-- Aug 70-Sep 76 (discont.)
South Wichita River at low flow dam near Guthrie, Texas (Bateman) #07311782	Lat 33°37'19", long 100°12'31, King County, 1.0 mi downstream from ranch road crossing, 2.9 mi upstream from Willow Creek, 6.6 mi east of Guthrie and 91.5 mi upstream from mouth.	223	Water-stage recorder Specific conductance and water temp. recorder Data Collection Platform (telemetry)	Oct 84 - Sep 85 May 87-current -- Mar 85-current	Oct 84-current -- Mar 85-current
South Wichita River below low flow near Guthrie, Texas (Bateman) #07311783	Lat 33°37'19", long 100°12'31, King County, 1.1 mi downstream from ranch road crossing, 2.8 mi upstream from Willow Creek, 6.6 mi east of Guthrie, and 91.4 mi upstream from mouth.	223	Water-stage recorder Specific conductance and water temp. recorder Data Collection Platform (telemetry)	Oct 85-current -- Oct 85-current	Oct 86-current year Oct 86-current
South Wichita River near Benjamin, Texas (Bateman) #07311800	Lat 33°38'39", long 99°48'02", on state highway 6 bridge, 4 mi north of Benjamin, and 41 mi upstream from mouth.	584	Water-stage recorder Specific conductance and water temp. recorder Data Collection Platform (telemetry)	Dec 59-current -- Mar 85-current	Aug 68-current year (daily water-quality stat. Oct 67- Aug 68) Mar 85-current

Water discharge records for station 07311782 since May 1987 represents flow pumped from the South Wichita River at the low flow dam and diverted by pipeline to Truscott Brine Lake. Flows are determined by the Corps of Engineers (recording flowmeter in pipeline) and records are furnished to the Geological Survey.

curves are extended by using: (1) logarithmic plotting; (2) velocity-area studies; (3) results of indirect measurements of peak discharge, such as slope-area or contracted opening measurements, and computation of flow over dams and weirs; or (4) step-backwater techniques.

Daily mean discharges are computed by applying the daily mean stage (gage heights) to the stage-discharge curves or tables. If the stage-discharge relation is subject to change because of frequent or continual change in the physical features that form the control, the daily mean discharge is determined by applying shifts (correction factors) based on individual discharge measurements and notes made by personnel who made the discharge measurements.

For periods of missing or grossly inaccurate gage-height record, the daily discharges are estimated from the recorded range in stage, previous and subsequent gage-height records, discharge measurements, weather records, and comparison with other station records from the same or nearby basins.

WATER-QUALITY RECORDS

Data obtained at a continuous-record water-quality station depend on the purpose of the station, the type of instrumentation, and the number and types of measurements and analyses. A comprehensive discussion of the various types of continuous-record water-quality stations operated by the Geological Survey is beyond the scope of this report. The following discussion is applicable to those stations in Area VIII of the South Wichita River where specific conductance is measured on daily samples or is recorded continuously by a digital conductivity monitor.

At daily sampling stations, water samples usually are collected at about the same time each day. During periods of rapidly changing flow, samples may be collected more frequently to determine the changes in water quality. At each station equipped with a digital conductivity monitor, specific conductance of the water is measured at hourly intervals. At each of these stations, at least six samples per year representing the range in specific conductance are collected and analyzed for specific conductance and the major dissolved-inorganic constituents and related properties.

Specific conductance is a measure of the ability of a water to conduct an electrical current and thus is related to the types and concentrations of major ions in solution. Consequently, specific conductance values can be used for approximating the concentrations of dissolved solids and the major inorganic ions dissolved in water. For each of the daily or digital conductivity monitoring stations, mean daily, monthly, and annual discharge-weighted concentrations and loads for selected dissolved chemical constituents including dissolved solids, chloride, and sulfate are computed using the daily records of water discharges and specific conductance and regression relationships between specific conductance and each of the chemical constituents.

For periods of missing or grossly inaccurate specific conductance record, daily values are estimated from recorded range in values, previous and subsequent records, regression relationships between specific conductance and

water discharge, and comparison with other nearby stations on the same stream.

SUMMARY OF FLOW AND WATER QUALITY RECORDS

The records on which this summary is based are for the period from May 1, 1987, through April 30, 1988. Locations of the Bateman Pump Station and the downstream gaging stations are shown on Figure 3. The complete daily records of the quantity and quality of the water diverted and the flow at stations downstream from the low-flow dam and near Benjamin are included in Appendix D and Appendix E. Monthly summaries are provided in Table 5, which includes the following:

(1) Monthly records of the quantities of flow and the concentrations and loads of chloride in flows diverted by pumpage,

(2) Monthly records of the quantities of flow and concentrations and loads of chloride in flow that passed downstream from the low-flow dam due to minor seepage under and around the dam, due to deflation of the dam when flows exceeded about 14 cfs and due to deflation of the dam during a 10-day period in January 1988 and a 7-day period in April 1988 when breaks were being repaired in the pipeline between the low-flow dam and Truscott Brine Lake. Hereafter, any or a combination of these flows that passed downstream is referred to as "spillage."

(3) Monthly records of the quantities of flow and concentrations and loads of chloride at the station near Benjamin.

Flow records show that monthly diversions ranged from 5.2 cfs in January 1988 to 11 cfs in June 1987 and averaged 7.2 cfs. The records show also that spillage at the station downstream from the low-flow dam ranged from less than 0.1 cfs during four months to 53 cfs during the extremely high-flow month of May 1987 and averaged 5.3 cfs. A comparison of these records shows that approximately 58 percent (7.2 of 12.5 cfs) of the total flow originating upstream from the Bateman Pump Station was diverted.

Water-quality records show that chloride concentrations in the monthly diversions ranged from 6,100 Mg/L during the relatively high flow month of June 1987 to 11,000 Mg/L during five months and averaged about 9,800 Mg/L. Conversely, chloride concentrations in spillage at the station downstream from the low-flow dam ranged from 1,100 Mg/L during the high-flow month of May to 11,000 Mg/L during February and April 1988. These data indicate that the diversion of the saline low flows resulted in an average reduction of 4,420 Mg/L of chloride in the spillage at the site downstream from the dam.

Water-quality records show that chloride loads in the monthly diversions ranged from 145 tons/day in January 1988 to 223 tons/day in March 1988 and averaged 192 tons/day. The records show also that chloride loads in spillage downstream from the low-flow dam ranged from less than 2 tons/day during four months to 158 tons/day during the high-flow month of May.

TABLE 5

WATER DISCHARGES AND CHLORIDE CONCENTRATIONS AND LOADS
FOR SELECTED SITES ON THE SOUTH WICHITA RIVER, TEXAS, MAY 1987 - APRIL 1988

Period	07311782 South Wichita River at Low Flow Dam at Bateman, Texas (Diversion)				07311783 South Wichita River below Low Flow Dam at Bateman Texas				07311800 South Wichita River near Benjamin, Texas			
	Water discharge (cfs)	Dissolved chloride (Mg/L) (tons)	chloride (tons/day)	Water discharge (cfs)	Dissolved chloride (Mg/L) (tons)	chloride (tons/day)	Water discharge (cfs)	Dissolved chloride (Mg/L) (tons)	chloride (tons/day)	Water discharge (cfs)	Dissolved chloride (Mg/L) (tons)	chloride (tons/day)
May 1987	5.7	10,000	4,800	155	53	1,100	4,900	158	249	920	19,070	613
June	11	6,100	5,400	180	3.0	5,100	1,300	40	108	1,700	14,806	500
July	8.0	8,600	5,800	187	2.8	5,800	1,400	45	32	2,800	7,357	239
August	7.1	10,000	6,100	197	.76	10,000	640	21	21	2,400	4,317	142
September	7.8	10,000	6,500	217	.06	8,800	46	1.5	8.2	2,600	1,754	60
October	6.9	11,000	6,200	200	.06	9,000	42	1.4	1.3	5,200	585	19
November	7.3	11,000	6,400	213	.05	9,400	36	1.2	1.1	5,900	542	18
December	7.7	10,000	6,600	213	.26	9,600	210	6.8	3.6	5,400	1,594	52
Jan. 1988	5.2	10,000	4,500	145	2.1	9,500	1,700	55	5.6	4,700	2,188	71
February	7.3	11,000	6,200	214	.15	11,000	120	4.1	3.0	5,700	1,320	45
March	7.4	11,000	6,900	223	.05	10,000	39	1.3	3.9	4,100	1,321	42
April	5.4	11,000	4,900	163	.81	11,000	730	24	4.0	3,800	1,215	40
May 1987- Apr 1988	7.2	9,770	70,300	192	5.35	2,100	11,163	30	37	1,550	56,067	153

Records for the station near Benjamin show that monthly flows ranged from 1.1 cfs in November 1987 to 249 cfs in May 1987 and averaged 37 cfs. The chloride concentration in these flows ranged from 920 Mg/L in May 1987 to 5,900 Mg/L in November 1987 and averaged 1,550 Mg/L. The monthly chloride loads ranged from 18 tons/day during November 1987 to 613 tons/day in May 1987 and averaged 153 tons/day.

PART III

ANALYSES AND CONCLUSIONS

ANALYSES AND CONCLUSIONS

In this part of the report, it is the purpose of the Panel to present Area VIII Chloride Control project data, and to use these data to determine the effectiveness of the project in accomplishing project objectives to improve water quality, as presented in "Supplemental Data to Arkansas - Red River Basin Chloride Control, Red River Basin, Design Memorandum No. 25, General Design, Phase I - Plan Formulation," Volume I, Department of the Army, Tulsa District, Corps of Engineers, Tulsa, Oklahoma, November 1980. The flow and chloride concentration data of Memorandum No. 25 were taken from Design Memorandum No. 3, U.S. Army Corps of Engineers, Tulsa District, Oklahoma, August 1972.

ACHIEVEMENT OBJECTIVES

As presented and explained in Memorandum No. 25, it is estimated that in the case of Area VIII, the Chloride Control project will intercept and divert 85 percent of the estimated 195 tons of chlorides that are entering the South Wichita River on the average day, upstream of the Ross Ranch pumping station site, by way of spring flows and seeps¹. It is specifically noted and emphasized by the Panel that in the economic reanalysis of 1980, no benefits were credited to the project until all project elements of the areas recommended for construction were completed. Following completion of project construction, which was estimated in the 1980 report to be 1990, the water quality benefits were phased in as Red River Water was used². The benefits were then allowed to grow as the use of the Red River water increased. Thus, it is the observation of the Panel, that the economic reanalysis of 1980 was based upon appropriate concepts, insofar as the benefits to water quality are concerned. Therefore, the task of the Panel can best be accomplished by evaluating physical parameters.

In its consideration of the 1980 reanalysis, the Panel concluded that the data currently being collected by the U.S. Geological Survey at the Bateman gages located upstream and downstream of the Bateman Pump Station, and the Benjamin gage located on the South Wichita River, approximately 50 river miles downstream of Bateman, were all that could be effectively used. The Panel further concluded that these data should be sufficient to allow proper evaluation of the effects of Area VIII operation. The Panel also determined that it would be unnecessary and outside the charge of the Panel to review the benefit reanalysis to decide if project benefits are being realized, but that a qualitative analysis of water quality would be sufficient. Therefore, the remainder of the Panel's efforts were directed toward analysis of stream flows, pump diversions at the Bateman station, and water quality data in order to evaluate the effectiveness of the existing parts of Area VIII Chloride Control project in the accomplishment of the levels of water quality improvement that were forecast for these parts of the Chloride Control project³. The results of these analyses and comparison are presented below.

¹"Design Memorandum No. 25, General Design, Phase I - Plan Formulation, Department of the Army, Tulsa District, Corps of Engineers, Tulsa, Oklahoma, November 1980; page II-16.

²Ibid pages III-97, III-105, and III-106.

³Panel meeting minutes of October 28, 1987.

PERFORMANCE AT BATEMAN

In the following discussion, data in the first full year of operation (from May 1, 1987 through April 30, 1988) of the Bateman Pump Station are presented and analyzed. Table 6 shows a summary of flows and chloride concentrations in the South Wichita River upstream from the pump station. Flows measured at the site averaged 12.5 cfs while loads were 222 tons/day for this period. The spilled portion averaged 5.3 cfs and 30.5 tons/day and an average of 7.2 cfs with a load of 192 tons/day was diverted (see Table 5). Figures 4 and 5 show graphical presentations of the flow and chloride data presented in Table 5.

A comparison of these records shows that diversions of the more saline low flows resulted in an 86-percent reduction (192 of 222 tons/day) of the chloride load in the flow passing downstream from the Bateman Pump Station. This occurred even though an average of more than 138 tons/day of chloride was spilled during the two shutdowns. (During the test period two pipeline breaks occurred reducing the effectiveness of the pumping effort. The first occurred January 11, 1988 necessitating 10 days of down-time. The second break was on April 22, 1988 necessitating 7 days of down-time. In both cases the breaks were quickly repaired and pumping resumed.)

The average degree of control was less than expected due to high flows in May 1987 (this was the wettest month of record). Flow in May averaged 58.7 cfs with a load of 313 tons/day. Pumping caught 5.7 cfs (about 10 percent of the flow) and 155 tons/day (about half of the load). In comparison, pumping diverted 89 percent (7.4 of the average flow of 8.3 cfs), and 91 percent (195 of the average load of 214 tons/day) for the period June 1987 through April 1988.

Only one other period of record exists for the Bateman location other than the present period of record which began October 1, 1984. This was during the water years of 1971 through 1976 which appears to represent relatively "average" flow conditions based on observations of the 27 years of record available for the Benjamin gaging stations (see Table 7). Projected chloride diversions were simulated for the 1971-76 period by assuming the Bateman Pumping station and diversion were in operation, and the data are presented in Table 8. The simulated data is based on the assumption that the same operating strategy and similar breakdowns occurred during that period as during the actual period of operation between May 1, 1987 and April 30, 1988.

Important observations which can be made from reviewing the data in Table 8 are:

On averages approximately 87 percent or more of the chlorides occurring upstream of the Bateman Pump Stations can be removed. Average (and total) flow and chloride loads were considerably higher than average during the test period.

The efficiency of chloride removal in terms of percentages diverted is not very sensitive to the large variations in average annual flows and chloride loads.

TABLE 6

WATER FLOWS AND CHLORIDE CONCENTRATIONS AND LOADS FOR THE
SOUTH WICHITA RIVER UPSTREAM FROM BATEMAN PUMP STATION

Period	Water discharge (cfs)	Dissolved chloride		
		(Mg/L)	(tons)	(tons/day)
May 1987	58.7	1,960	9,700	313
June	14.0	5,890	6,700	220
July	10.8	7,870	7,200	232
August	7.86	10,000	6,740	218
September	7.86	10,000	6,546	218
October	6.96	11,000	6,242	201
November	7.35	11,000	6,436	214
December	7.96	10,000	6,810	220
January 1988	7.30	9,860	6,200	200
February	7.45	11,000	6,320	218
March	7.45	11,000	6,939	224
<u>April</u>	<u>6.21</u>	<u>11,000</u>	<u>5,630</u>	<u>187</u>
May 1987- April 1988	12.5	6,520	81,463	222
October 1970- September 1976	5.25	10,700		154

TABLE 7

BENJAMIN MONTHLY FLOWS (DSF)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1961										150	612	224	
1962	232	141	156	838	157	4,465	313	110	4,333	633	832	325	12,537
1963	211	192	183	227	1,309	1,044	252	0	1,183	42	412	170	5,225
1964	150	453	152	95	247	1,689	20	34	3,286	169	1,008	278	7,583
1965	206	137	147	1,033	327	57	0	5,935	8,133	7,575	501	345	24,396
1966	267	230	279	665	146	2,797	138	11,175	15,064	722	373	303	32,158
1967	273	195	162	4,195	3,523	9,352	2,060	293	514	119	177	204	21,069
1968	1,526	657	2,347	558	421	664	1,235	387	25	116	309	195	8,442
1969	166	176	225	157	2,235	467	20	821	7,515	4,545	1,323	547	18,199
1970	436	290	2,751	585	382	117	2	9	272	206	133	155	5,338
1971	162	129	108	116	4,306	788	142	2,271	832	2,478	581	662	12,575
1972	254	225	196	4,736	1,915	1,476	1,575	4,346	4,777	2,526	930	373	23,330
1973	585	677	1,972	1,613	439	180	470	167	1,905	229	607	184	9,028
1974	145	130	150	459	947	2,351	12	66	3,634	1,342	542	288	10,066
1975	301	762	313	509	7,012	2,277	3,859	1,296	2,252	318	1,412	285	20,597
1976	246	245	269	826	231	45	512	1,140	771	2,726	449	273	7,732
1977	232	237	231	1,244	4,258	537	96	176	65	237	193	163	7,668
1978	160	231	167	93	383	217	19	2,062	1,502	235	313	97	5,480
1979	190	156	538	252	1,044	944	450	1,083	30	5	300	157	5,149
1980	220	191	141	179	7,069	350	8	108	715	248	262	419	9,910
1981	215	243	485	560	1,280	3,066	11	1,242	299	881	241	235	8,759
1982	260	310	505	315	5,964	10,763	678	186	234	113	214	290	19,831
1983	481	383	338	538	721	1,056	76	2	1	20,347	1,331	664	25,938
1984	542	465	412	312	229	162	83	373	97	211	556	1,277	4,719
1985	545	322	1,584	1,413	166	2,386	301	116	326	5,747	643	367	13,918
1986	246	228	212	127	1,814	1,149	5,020	1,105	5,490	13,376	1,952	1,281	32,002
1987	974	1,651	1,770	486	7,708	3,226	979	659	247	42	34	110	17,887
1988	172	86	120	118									
Mean	348	339	589	824	2,086	1,986	705	1,352	2,442	2,420	602	366	14,213

TABLE 8

SUMMARY OF AVERAGE DAILY VALUES OF FLOW AND ACTUAL AND
PROJECTED CHLORIDE DATA AND PERCENTAGES DIVERTED AT BATEMAN PUMPING STATION

Period	Diverted (tons/day)	Spilled (tons/day)	Total		Percentage Diverted (%)
			(tons/day)	(cfs)	
Test Period	<u>Actual</u>				
May 87-Apr 88	192	30	222	12.5	86
Water Year	<u>Projected*</u>				
1985	105	5	110	3.6	95
1986	133	60	195	20.8	68
1971	107	17	124	6.3	86
1972	153	12	165	5.4	93
1973	165	16	181	5.4	91
1974	151	12	163	4.9	93
1975	132	18	150	5.5	89
1976	<u>134</u>	<u>16</u>	<u>150</u>	<u>3.9</u>	<u>89</u>
<u>Avg. 71-76</u>	<u>140</u>	<u>13</u>	<u>153</u>	<u>5.25</u>	<u>92</u>
Overall 9-yr. Average	141.3	20.9	162.2	7.6	87

*Assuming same operational program and two breakdowns totaling 17 days as during test period. The average concentrations which was assumed to be spilled during water year 1971-1976 was computed to be approximately:

$$\frac{138 \text{ tons/day} \times 17 \text{ days}}{365 \text{ days/year}} \times \frac{154 \text{ tons/day}}{222 \text{ tons/day}} = 5 \text{ tons/day}$$

BATEMAN MONTHLY MEAN DISCHARGES **MAY 1987 - APRIL 1988**

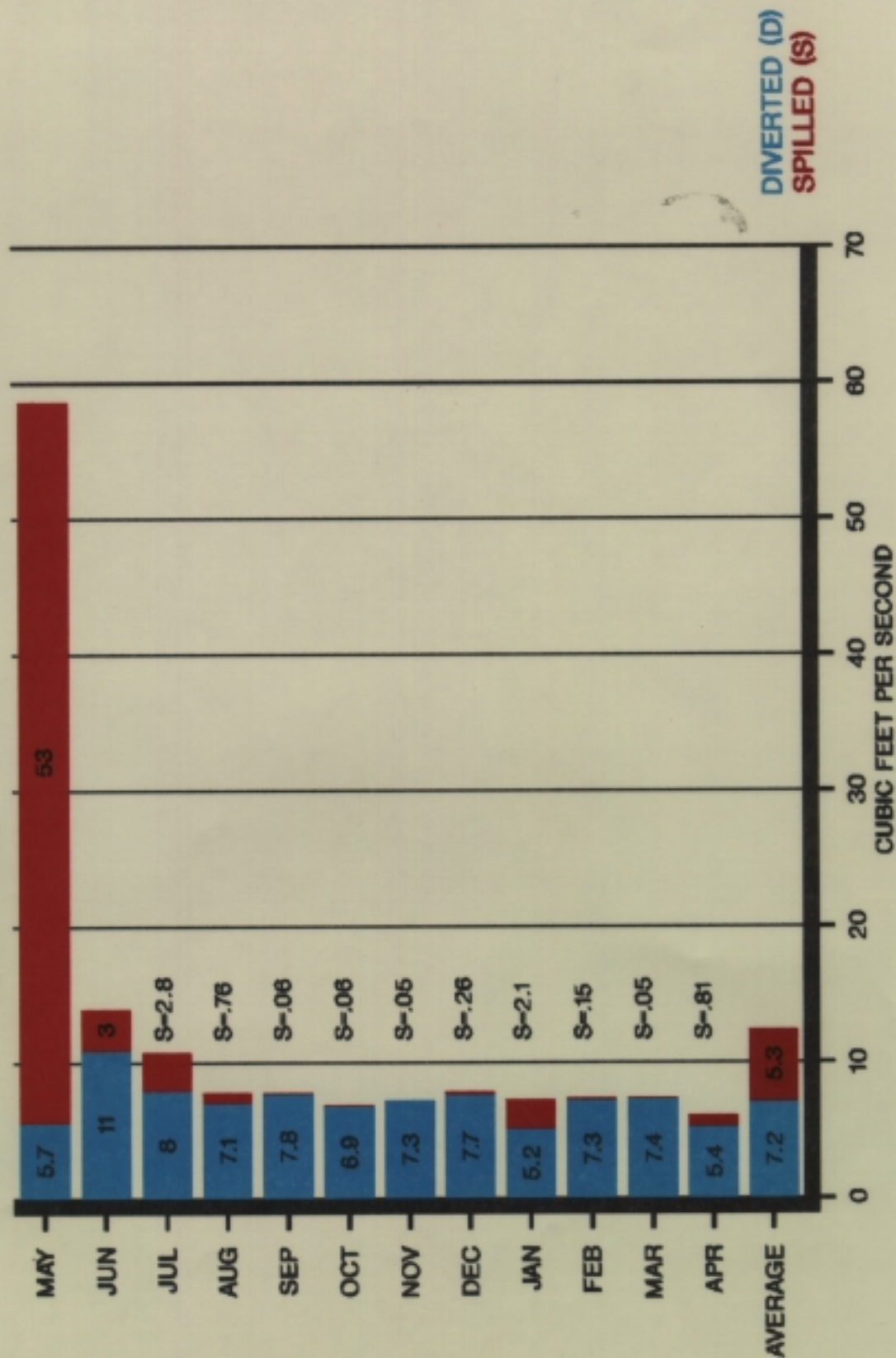


FIGURE 4

BATEMAN MONTHLY MEAN DISSOLVED-CHLORIDE LOADS

MAY 1987 - APRIL 1988

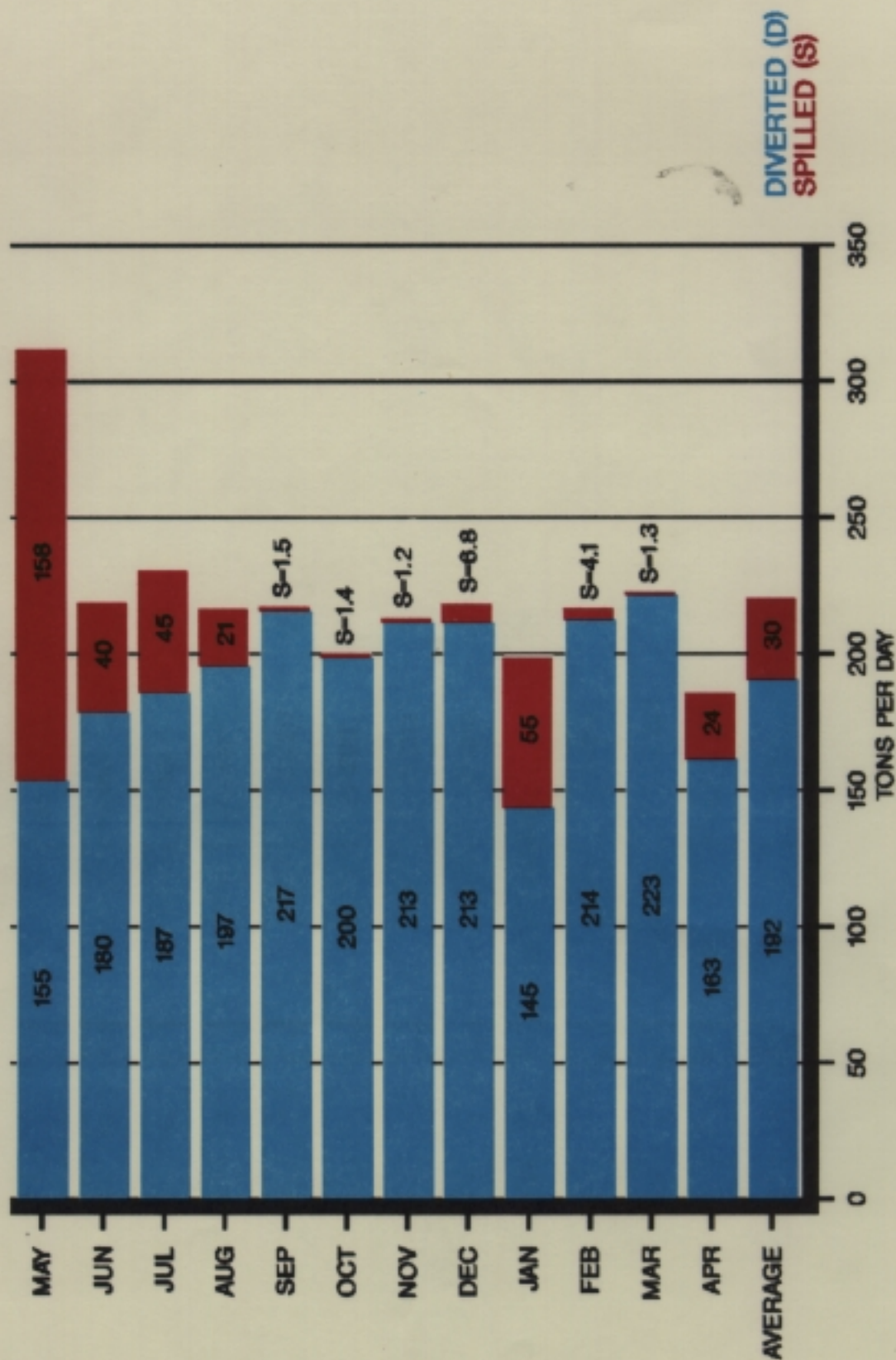


FIGURE 5

The two system breakdowns experienced during the test period (and assumed for each year in the simulation analysis) only caused an average 3- to 4-percent reduction in overall efficiency. The operational strategy used during the test period is an effective (suitable) strategy.

Both water year 1986 and the test period in 1987-88 were considerably wet and thus, flows were greater and carried more chlorides than normal although the concentrations were diluted by the high flows.

Examination of the quoted data confirms that the control system is operating better than predicted in design. The relative degree of control during the test period was somewhat reduced due to high flows in May of 1987 and by the two pipeline breaks. High flow periods will occur from time to time throughout the life of such a project but should not constitute a very large portion of the time as an average. Pipeline breaks will also occur during the operational phase, but the total down-time is not expected to rise in future years and may even drop as experience in repairs is accumulated. Considering these adjustments the expected level of control over the anticipated project life is estimated to be at least 87 percent as depicted in Table 8. This compares favorably to the forecast level of control used for design purposes (see Design Memorandum Nos. 3 and 25) which ranged from 83 to 85 percent.

PERFORMANCE AT BENJAMIN

Before measurable improvements of quality can be realized in impacted streams and lakes along the Red River, flushing of stored brines contained in alluvium waters must take place. A major concern addressed by the Chloride Control Feasibility Study was the estimated time required to flush these chloride loads. Significant flushing of brines was observed between the Bateman and Benjamin sites during the one-year operation indicating a much shorter time frame for this flushing action to occur than was originally envisioned.

The period of continuous concurrent streamflow and water-quality record for the South Wichita River at Bateman and near Benjamin is from October 1970 through September 1976. Flows near Benjamin averaged 36.2 cfs during this 6-year period and about 38.3 cfs during the 26-year period from October 1961 through September 1986. Distribution of flows for the two periods are very similar. Consequently, the water-quality records for both Bateman and Benjamin stations are considered to be representative of the long-term pre-pumping conditions.

During this 6-year period, chloride loads in flows near Benjamin averaged 210 tons/day. During the one-year period from May 1987 through April 1988 with pumping underway at Bateman, flows at Benjamin averaged 37 cfs and chloride loads averaged 153 tons/day.

According to the Chloride Control Plan for Area VIII, pumpage of an average chloride load of 142 tons/day at Bateman would reduce the average chloride load at Benjamin to about 68 tons/day. However, pumpage of an average chloride load of 192 tons/day at Bateman during the one-year period reduced the average chloride load at Benjamin to only 153 tons/day. This

discrepancy is readily explainable. According to estimates by the U.S. Army Corps of Engineers, "Between the Bateman gage and Benjamin gage, an estimate 250,000 tons of chloride are dissolved in the pore water in alluvial silt deposits. Flushing of the stored brine in the alluvium must take place for definable improvements of quality parameters at Benjamin. Considerable flushing could occur in one normally wet spring."

Available data indicate that the much greater-than-average flows in May and June 1987 (a large part of which originated from flood runoff downstream from Bateman) resulted in significant flushing of chloride from the alluvium in the intervening reach between Bateman and Benjamin (see Appendix B and Tables 5, 6, and 7 and Figure 6).

Monthly chloride loads contributed by the intervening area in May and June 1987 averaged 455 and 460 tons/day as indicated in Table 9. Corresponding flow contributions in May and June averaged 196 and 105 cfs. In July and August, as the flows receded to 29.2 and 20.2 cfs, the monthly chloride loads decreased to 194 and 121 tons/day, respectively. Throughout the remainder of the period from September 1987 through April 1988, the monthly flows contributed by the intervening area were significantly less than the long-term average. Monthly loads during this period ranged from 16 to 58 tons/day. This was the result of the flushing of the chlorides in the alluvium between Bateman and Benjamin. This flushing lowered the chloride concentration and improved the quality of the alluvium water. Future water coming out of the alluvium will contain less chlorides than before since the highly chloride concentrated base flows will be diverted at Bateman and no longer contribute to the alluvium's chloride concentration during low flow periods.

The six-year flow for this area and the one-year flow after the onset of pumping agree remarkably well -- 31.4 and 31.6 cfs. However, the average chloride load contributed by this area after the onset of pumping was much larger than the six-year pre-pumping average -- 123 and 71 tons/day, respectively. The increasing load with no additional source is another indication of significant flushing of brine from the alluvium downstream from Bateman. After initial flushout, chloride loads at Benjamin during the period from September 1, 1987, to April 30, 1988, ranged from 18 to 71 tons/day and averaged 42 tons/day, about 26 tons less than the anticipated long-term value.

Figure 6 shows an estimate of the leaching progress between Bateman and Benjamin and is a plot of the data on Table 10. Flows during this eight-month period averaged less than 4 cfs. After the initial flushing by high flows, the observed daily chloride loads at Benjamin were smaller for equivalent flows (see Figure 7).

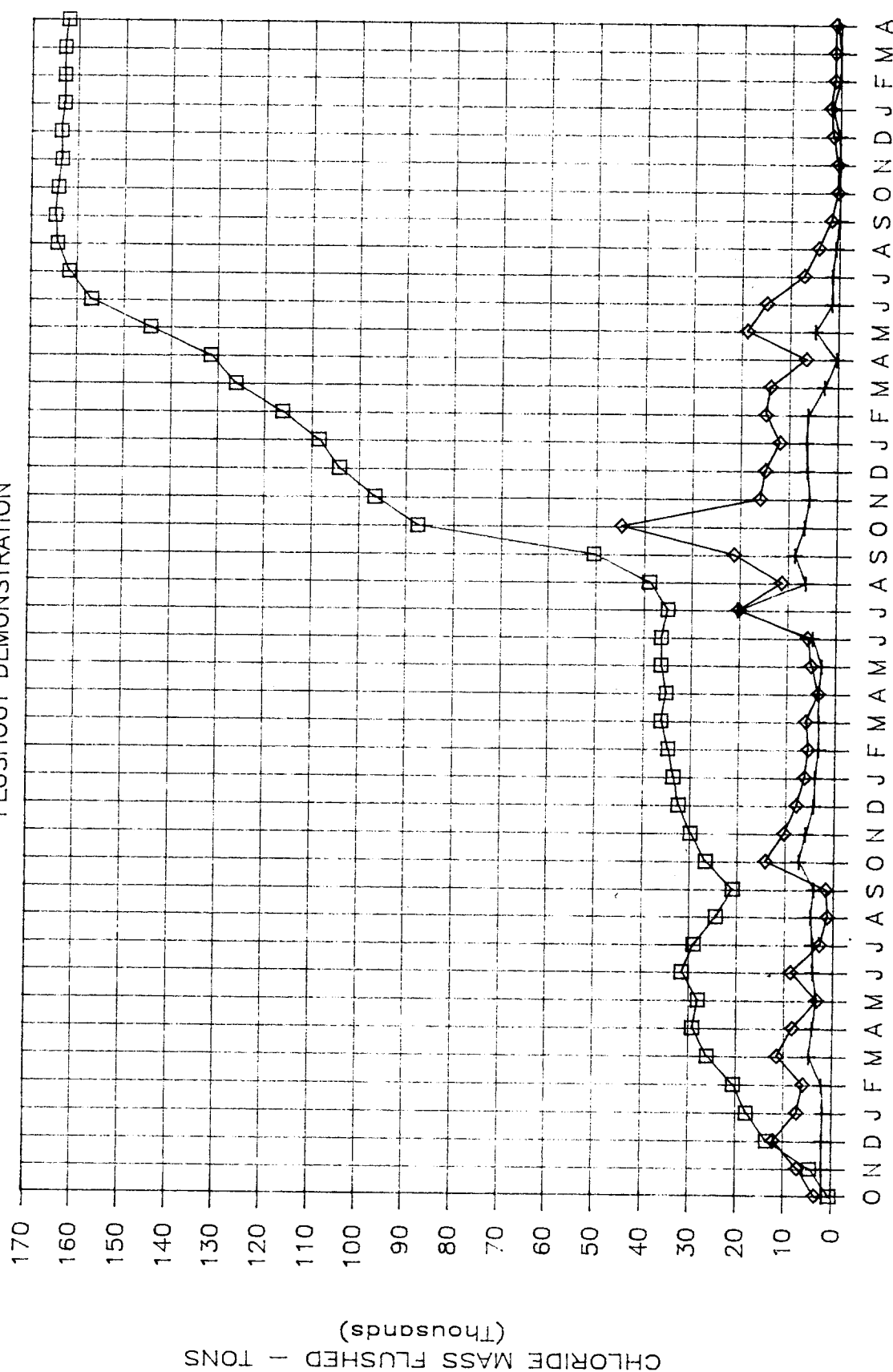
The chloride control system effectiveness at Benjamin was demonstrated by the significant flushing action that was observed during the one-year operation. As the chloride load flushed from the alluvium continues to decline through the project life, a progressively greater degree of effectiveness of the Bateman Pump Station Operation will be prevalent.

TABLE 9

AVERAGE WATER DISCHARGES AND CHLORIDE CONCENTRATIONS AND LOADS
CONTRIBUTED BY INTERVENING AREA BETWEEN BATEMAN AND BENJAMIN

Period	Water discharge (cfs)	Dissolved chloride		
		(Mg/L)	(tons)	(tons/day)
May 1987	196	870	14,100	455
June	105	1,600	13,800	460
July	29.2	2,510	6,010	194
August	20.2	2,120	3,750	121
September	8.14	2,550	1,740	58
October	1.24	5,020	530	17
November	1.05	5,730	510	17
December	3.34	5,070	1,400	45
January 1988	3.50	1,820	500	16
February	2.85	5,420	1,190	41
March	3.85	4,020	1,279	41
<u>April</u>	<u>3.19</u>	<u>1,970</u>	<u>480</u>	<u>16</u>
May 1987- April 1988	31.6	1,450	45,280	123
October 1970- September 1976	31.4	910		71

FLUSHOUT DEMONSTRATION



1984 - 1988

+ BATEMAN TONS ◇ BENJAMIN TONS

Estimate of the Leaching Progress Between Bateman and Benjamin

FIGURE 6

LEACHED TONS

TABLE 10

ESTIMATE OF LEACHING BETWEEN BATEMAN AND BENJAMIN

	Tons Passing Bateman	Tons Passing Benjamin	Intervening Load Tons	Estimated Leached Tonnage	Accum Leached Load
Oct 84	1,900	3,640	1,200	540	540
Nov 84	1,990	7,240	1,200	4,050	4,590
Dec 84	2,040	12,200	1,200	8,960	13,550
Jan 85	1,810	7,330	1,200	4,320	17,870
Feb 85	2,210	6,130	1,200	2,720	20,590
Mar 85	4,830	11,600	1,200	5,570	26,160
Apr 85	4,060	8,420	1,200	3,160	29,320
May 85	3,320	3,390	1,200	-1,130	28,190
Jun 85	4,160	8,810	1,200	3,450	31,640
Jul 85	4,250	2,900	1,200	-2,550	29,090
Aug 85	4,760	1,340	1,200	-4,620	24,470
Sep 85	4,020	1,720	1,200	-3,500	20,970
Oct 85	7,270	14,200	1,200	5,730	26,700
Nov 85	5,870	10,400	1,200	3,330	30,030
Dec 85	4,160	7,910	1,200	2,550	32,580
Jan 86	3,970	6,290	1,200	1,120	33,700
Feb 86	3,320	5,670	1,200	1,150	34,850
Mar 86	3,470	6,200	1,200	1,530	36,380
Apr 86	3,430	3,600	1,200	-1,030	35,350
May 86	2,810	5,170	1,200	1,160	36,510
Jun 86	4,860	6,030	1,200	-30	36,480
Jul 86	20,400	20,300	1,200	-1,300	35,180
Aug 86	6,390	11,500	1,200	3,910	39,090
Sep 86	8,710	21,400	1,200	11,490	50,580
Oct 86	6,700	45,000	1,200	37,100	87,680
Nov 86	5,700	16,000	1,200	9,100	96,780
Dec 86	6,300	15,000	1,200	7,500	104,280
Jan 87	6,500	12,000	1,200	4,300	108,580
Feb 87	6,100	15,000	1,200	7,700	116,280
Mar 87	2,800	14,000	1,200	10,000	126,280
Apr 87	310	6,800	1,200	5,290	131,570
May 87	4,900	19,000	1,200	12,900	144,470
Jun 87	1,300	15,000	1,200	12,500	156,970
Jul 87	1,400	7,400	1,200	4,800	161,770
Aug 87	640	4,400	1,200	2,560	164,330
Sep 87	46	1,800	1,200	554	164,884
Oct 87	42	590	1,200	-652	164,232
Nov 87	36	540	1,200	-696	163,536
Dec 87	210	1,600	1,200	190	163,726
Jan 88	1,700	2,200	1,200	-700	163,026
Feb 88	120	1,300	1,200	-20	163,006
Mar 88	39	1,300	1,200	61	163,067
Apr 88	730	1,200	1,200	-730	162,337

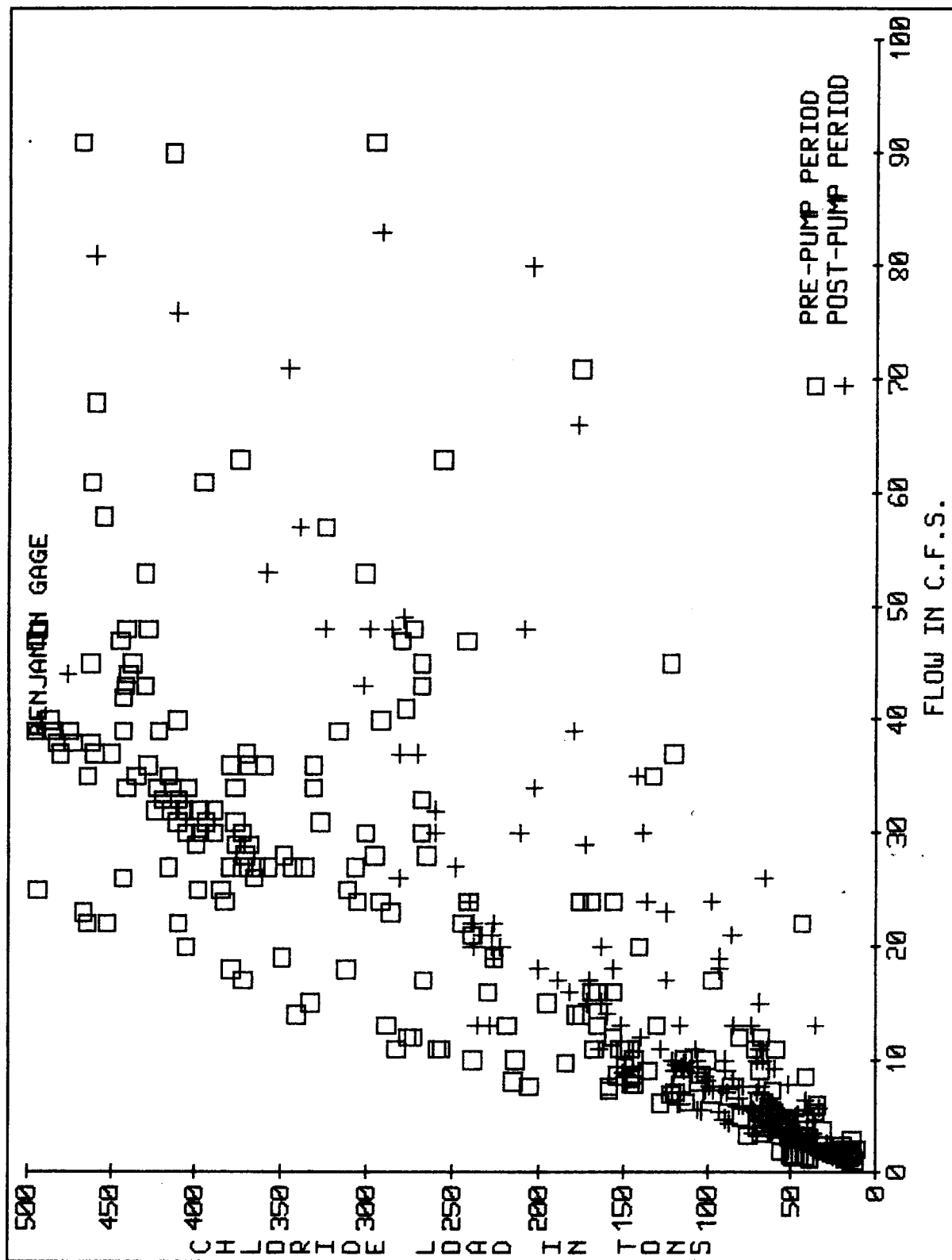


FIGURE 7
Comparison Between Chloride Loads During
Pre and Post Pump Periods at Benjamin

APPENDICES

APPENDIX A

LETTER AUTHORIZING PANEL



DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, DC 20310-0103

14 AUG 1987

Professor Jack Keller
Department of Agricultural
and Irrigation Engineering
Utah State University
Logan, Utah 84322-4105

Dear Professor Keller:

I am very pleased to inform you that I am formally constituting and commissioning the Red River Chloride Control Project Evaluation Panel to assess the effectiveness of area VIII of the Red River Chloride Control project. The members of the panel are:

- > Dr. Herbert Grubb;
- > Professor Jack Keller;
- > Mr. Jack Kramer;
- > Mr. Jack Rawson; and
- > Mr. Glenn Sullivan.

You have agreed to serve as Chairman, and Mr. Rawson has agreed to serve as Vice Chairman.

I also have asked the Commander of the Southwestern Division of the Army Corps of Engineers to consult with you to arrange a meeting date in late September or October 1987 to initiate the activities of the panel. I would anticipate that the panel's first meeting would include a visit to area VIII and a first-hand viewing of the site and the works that are now in operation there.

Enclosed is information relating to the members of the panel, a copy of Section 1107 of Public Law 99-662, a charter to guide the panel's activities, and a paper containing useful background information. As indicated in the charter, the Commander of the Southwestern Division will designate a point of contact to assure that the panel receives the necessary technical and administrative support from the Corps. Major General Jerome B. Hilmes is the Commander, and his address is U.S. Army Engineer Division, Southwestern, 1114 Commerce Street, Dallas, Texas 75242-0216. Under separate cover you will receive a copy of the Corps recommendations regarding General Design Memorandum numbered 25 by the Director of Civil Works on behalf of the Chief of Engineers, dated August 8, 1977, referenced in Public Law 99-662.

I consider the assignment given to the panel to be an important one not only for the Red River Chloride Control project but for other projects of this type as well. I am sure that each of you will take your responsibilities most seriously and deliver your best professional judgment with regard to the correspondence between the actual performance of area VIII and that assumed in the Corps reanalysis of November 1980.

I extend to you my best wishes for an expeditious fulfillment of the charter given to you by Public Law 99-662.

Sincerely,

John S. Doyle, Jr.
Acting Assistant Secretary of the Army
(Civil Works)

Enclosures

Similar letter sent to Jack Rawson, Jack Kramer,
Herbert Grubb, and Glenn Sullivan

MEMBERS
RED RIVER CHLORIDE CONTROL PROJECT
EVALUATION PANEL

Professor Jack Keller - Chairman
Department of Agricultural
and Irrigation Engineering
Utah State University
Logan, Utah 84322-4105
801-750-2785

Mr. Jack Rawson - Vice Chairman
Water Resources Division
United States Geological Survey
649 Federal Building
300 East 8th Street
Austin, Texas 78701
512-482-5766

Dr. Herbert Grubb
Director of Planning
Texas Water Development Board
Capitol Station
Post Office Box 13231
Austin, Texas 78711-3231
512-463-7868

Mr. Jack Kramer
Texas Water Commission
Post Office Box 13087
Austin, Texas 78711
512-463-7791

Mr. Glenn Sullivan
Secretary of Natural Resources
Office of the Governor
State of Oklahoma
Oklahoma City, Oklahoma 73105
405-521-2413

ble. Except as specifically provided herein all transactions will be in accordance with existing laws and procedures.

SEC. 1107. RED RIVER CHLORIDE CONTROL

(a) The first sentence of the paragraph under the center heading "ARKANSAS AND RED RIVERS" in section 203 of the Flood Control Act of 1966 is amended by striking out "\$46,400,000" and inserting in lieu thereof "\$177,600,000".

(b) Section 201 of the Flood Control Act of 1970, as amended by section 153 of the Water Resources Development Act of 1976, is amended by striking out the last sentence under the heading "ARKANSAS-RED RIVER BASIN" and inserting in lieu thereof the following: "Construction shall not be initiated on any element of such project involving the Arkansas River Basin until such element has been approved by the Secretary of the Army. The chloride control projects for the Red River Basin and the Arkansas River Basin shall be considered to be authorized as separate projects with separate authority under section 203 of the Flood Control Act of 1966."

(c) Construction of remaining elements of the project involving the Red River Basin shall be initiated in accordance with the recommendations regarding general design memorandum numbered 25 by the director of civil works on behalf of the Chief of Engineers, dated August 8, 1977. Such construction shall commence upon transmittal of a report to the Secretary and to the Committee on Environment and Public Works of the Senate and the Committee on Public Works and Transportation of the House of Representatives of a favorable finding of the effectiveness of the operation of area VIII, to be made by a panel consisting of representatives of the United States Geological Survey and the Texas Water Commission, a person selected by the National Academy of Sciences, and two other qualified persons to be appointed by the Secretary with the concurrence of the governors of Texas and Oklahoma. The panel shall assess the improvement in water quality downstream of area VIII to determine its consistency with the water quality assumed in the development of project benefits in the economic reanalysis of the project completed in November 1980. Such report shall be submitted to the Secretary and to such committees no later than three years after the date area VIII commences operation. Cost sharing for construction on the Red River Basin project initiated under this section shall be the same as the cost sharing for area VIII of the project.

SEC. 1108. ST. JOHN'S RIVER BASIN, MAINE.

(a) The Secretary is authorized to implement a program of research in order to demonstrate the cropland irrigation and conservation techniques described in the report issued by the New England division engineer, dated May 1980, for the Saint John River Basin, Maine. The non-Federal share of the cost of such program shall be 35 percent.

(b) For the purposes of this section, there is authorized to be appropriated \$1,825,000 for fiscal year 1988, \$820,000 for fiscal year 1989, and \$785,000 for fiscal year 1990, such sums to remain available until expended.

SEC. 1109. PROHIBITION ON GREAT LAKES DIVERSIONS

(a) The Congress finds and declares that—

**CHARTER OF THE RED RIVER CHLORIDE
CONTROL PROJECT EVALUATION PANEL**

A. PANEL'S OFFICIAL DESIGNATION: Red River Chloride Control Project Evaluation Panel.

B. OBJECTIVES AND SCOPE: As defined in Section 1107 of Public Law (P.L.) 99-662, the panel shall assess the improvement in water quality downstream of area VIII of the Red River Chloride Control project to determine its consistency with the water quality assumed in the development of the project benefits in the economic reanalysis of the project completed in November 1980. The panel shall submit a report of its findings to the Secretary of the Army and to the Committee on Environment and Public Works of the Senate and the Committee on Public Works and Transportation of the House of Representatives.

C. DURATION: The panel has been established as the Red River Chloride Control Project Evaluation Panel under Section 1107 of P.L. 99-662. The panel will function until it submits a report of its findings to the Secretary of the Army and to the Committee on Environment and Public Works of the Senate and the Committee on Public Works and Transportation of the House of Representatives. As prescribed in P.L. 99-662, the report shall be submitted not later than three years after the date area VIII commenced operation. Area VIII commenced operation on May 11, 1987; therefore, the panel shall cease functioning not later than May 11, 1990.

D. OFFICIAL TO WHOM PANEL REPORTS: The panel will report to the Secretary of the Army, through the Assistant Secretary of the Army for Civil Works.

E. SPONSOR AND AGENCY PROVIDING SUPPORT: The United States Army Corps of Engineers will be the sponsor and will furnish secretarial, clerical, and other services as requested by the panel. The Commander, Southwestern Division, Corps of Engineers, will designate a point of contact for all matters relating to the activities of the panel. The Texas Water Commission also has agreed to provide administrative support upon request by the panel.

F. DUTIES: The evaluation panel shall assess the improvement in water quality downstream of area VIII of the Red River Chloride Control project to determine its consistency with the water quality assumed in the development of project benefits in the economic reanalysis of the project completed in November 1980. The panel shall submit a report of its findings to the Secretary of the Army and to the congressional committees not later than May 11, 1990.

G. FREQUENCY OF MEETINGS: The Commander, Southwestern Division, Corps of Engineers, after consulting with the Chairman, will convene the panel at Truscott Brine Lake or other appropriate designated location for an onsite review of the Red River Chloride Control project to be conducted by the Tulsa District of the Corps. Subsequent meetings will be convened by the Chairman at places designated by him to facilitate the work of the panel as necessary to fulfill the panel's stated objective.

H. TERMINATION DATE: The panel will terminate upon submittal of a report of its findings to the Secretary of the Army and the congressional committees not later than May 11, 1990.

I. COMPOSITION AND TERMS OF MEMBERSHIP:

1. The panel will consist of five members:

a. Mr. Jack Rawson, representing the United States Geological Survey;

b. Mr. Jack Kramer, representing the Texas Water Commission;

c. Professor Jack Keller, National Academy of Engineering, selected by the Acting Assistant Secretary of the Army (Civil Works) from candidates suggested by the National Research Council;

d. Mr. Glenn Sullivan, Secretary of Natural Resources for the State of Oklahoma; and

e. Dr. Herbert Grubb, Director of Planning for the Texas Water Development Board.

Mr. Sullivan and Dr. Grubb were selected by the Acting Assistant Secretary of the Army (Civil Works) upon the recommendation of the Governors of Oklahoma and Texas, respectively.

2. The Assistant Secretary of the Army has designated Professor Jack Keller as the Chairman and Mr. Jack Rawson as Vice Chairman.

3. The terms of office shall expire upon submittal of a report of the panel's findings to the Secretary of the Army and the congressional committees not later than May 11, 1990.

4. Panel members will not be compensated for their services. Upon their request to the Southwestern Division's point of contact, members may be reimbursed for travel expenses, subsistence, and accommodation as allowed by current regulations.

INFORMATION FOR THE RED RIVER CHLORIDE
CONTROL PROJECT EVALUATION PANEL

SECTION 1107 OF P.L. 99-662

Section 1107 of P.L. 99-662 states that the construction of the remaining elements of the Red River Chloride project shall be initiated in accordance with the recommendations regarding general design memorandum numbered 25 by the Director of Civil Works on behalf of the Chief of Engineers, dated August 8, 1977. Such construction may commence upon transmittal of a report to the Secretary and to the Committee on Environment and Public Works of the Senate and the Committee on Public Works and Transportation of the House of Representatives of a favorable finding of the effectiveness of the operation of Area VIII, to be made by the panel. The report shall be submitted to the Secretary and to such committees no later than three years after the date Area VIII commences operation. Cost sharing for construction on the Red River Basin project initiated under this section shall be the same as the cost sharing for Area VIII of the project. The Area VIII project was dedicated on May 11, 1987.

WATER QUALITY DATA

The final determination of the requirements and data collection stations will be made by the panel. The effectiveness of the Bateman pump station will be evaluated by monitoring the quantity and quality of stream flows and brine water pumped. Stream flow quantity and quality will be monitored by existing USGS gages located immediately upstream and downstream of the Bateman pump station and at the Benjamin gage. The quantity and quality of water pumped will be monitored at the Bateman collection point (Guthrie gage). All data collected can be evaluated to determine pump station effectiveness.

In order to assist the panel in the evaluation of the effectiveness of the operation of Area VIII, three full record stations have been installed. These stations record flow and water quality data collected in the Wichita River basin which would be affected by the operation of Bateman Pump Station. These are Guthrie gage at the Bateman Pump Station, Benjamin gage located five miles north of Benjamin, Texas, on the State Highway 6 bridge across the Southfork of the Wichita River, and Maybelle gage immediately downstream of Lake Kemp on the Big Wichita River. Flows and loads captured by pumping will be defined using gage data and the Truscott pipeline flow meter. Remaining flows and loads are measured by the downstream gage at the low-flow dam. Control system effectiveness can be demonstrated by the monthly flows and loads passing downstream with the pumping plant in operation.

Data collected during the operation of the Bateman pump station can be used to evaluate the level of chloride control during the test period, predict the level of control during comparable stream flow periods, and predict the long term level of control. The level of control during the test period will be evaluated directly from data collected. Chloride control for comparable periods will be predicted using water flow and quality data from past records. Statistical data, past water quality and stream flow records, and information obtained during the test period can be used to predict the long term level of chloride control due to Bateman pump station operation.

Total load at the Benjamin gage is 210 tons per day (T/D) through the recorded period. With Bateman operating it is expected that approximately 68 T/D will remain. Between the Bateman gage and Benjamin gage an estimated 250,000 tons of chloride are dissolved in the pore water in alluvial silt deposits. Flushing of this stored brine in the alluvium must take place for definable improvement of quality parameters at Benjamin to take place. Flushing could occur in one normally wet spring. Preparation of a report should be possible shortly after the collection period ends. A period of 18 months would be required to show load control at Benjamin gage with a greater than 50 percent chance of normal flow conditions.

Maybelle gage, located immediately below Lake Kemp, would not show an improvement in water quality parameters until initial flushing of the upstream channel and flushing of the alluvial storage mentioned in paragraph 3-03 has occurred. Stored waters in Lake Kemp will delay the effects of Bateman's load removal. Normal load at Maybelle gage has been 450 T/D over the period of record. The expected load after the full effect of Bateman would be 308 T/D due to other defined and undefined sources. Time is necessary to collect sufficient data to confidently show the estimated load reduction is occurring since the contrasts of before and after are less sharp, and the flushing must take place. For this report the data collected at Maybelle gage will probably not be used as no less than five years could elapse before the expected control could confidently be expected and demonstrated with Bateman as the only control point.

ECONOMIC REANALYSIS AND ASSUMPTIONS

The following information described in subsequent paragraphs is taken from Design Memorandum No. 25, dated November 1980 and discusses the economic reanalysis and assumptions.

The improvement of water quality in the Red River Basin would result in major benefits to the municipal and industrial user and to the agricultural user. The concepts, methodologies and procedures used in the evaluation are discussed in the Economic Reanalysis Summary section.

The municipal and industrial benefits are measured as water quality benefits, water supply benefits, or induced benefits. Water quality benefits are calculated when Red River water is used with or without the project. The benefit is a measure of the quality cost of water (either the cost of treatment to acceptable standard or the damage cost as a result of no treatment) without the project compared to with the project. The water supply benefit is calculated if Red River water is used only with the project and is the value of the least costly alternative with the project. Induced benefits result when more water is used with the project than without.

Net agricultural benefits are estimated as the average annual value of the difference in net crop returns with the project as compared with net crop returns without the project. It is necessary to project the type and amount of the various crops expected to be grown over the 100-year period with and without the project. The basic assumption behind the forecast of cropping patterns with and without the project is that they will be based on providing the maximum possible net revenue to the farmer. The combination of crops which will provide the maximum possible net revenue is the optimal crop mix. An optimal crop mix is estimated for each reach, with irrigable land (acreages of each soil type) and irrigation water as resource constraints. Differences in net revenues occur primarily from the higher yields resulting from increased irrigation with water of improved quality.

APPENDIX B

SOUTH WICHITA RIVER NEAR BENJAMIN, TEXAS
MONTHLY AND ANNUAL MEANS AND LOADS
FOR OCTOBER 1970 TO SEPTEMBER 1976

SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

MONTHLY AND ANNUAL MEANS AND LOADS FOR OCTOBER 1970 TO SEPTEMBER 1971

SPECIFIC CONDUCTIVITY		DISCHARGE (LFS-DAYS)		DIS- SOLVED SOLIDS (MG/L)		DIS- SOLVED CHLORIDE (MG/L)		DIS- SOLVED CHLORIDE (TONS)		DIS- SOLVED SULFATE (MG/L)		DIS- SOLVED SULFATE (TONS)		HARDNESS (CA, MG)	
MONTH	YEAR	(LFS-DAYS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)
OCT.	1970	206	22100	15000	8400	7300	9100	2300	1300	3100					
NOV.	1970	133	37000	25000	9100	13000	4600	3200	1100	4700					
DEC.	1970	155	35600	24000	10000	12000	5100	3200	1300	4500					
JAN.	1971	162	35000	24000	11000	12000	5300	3200	1400	4500					
FEB.	1971	129	35400	24000	8500	12000	4300	3200	1100	4500					
MAR.	1971	108	39200	27000	7800	14000	4000	3200	920	4300					
APR.	1971	116	32800	22000	7000	11000	3600	2800	880	4200					
MAY	1971	4306	1990	1400	16000	590	6800	300	3500	340					
JUNE	1971	708	9850	6800	14000	3000	6400	1400	2900	1500					
JULY	1971	142	5560	3900	1500	1700	630	830	320	360					
AUG.	1971	2271	5690	3900	24000	1700	10000	870	5300	390					
SEPT	1971	832	12700	8800	20000	3900	8800	1700	3800	2100					
TOTAL		9348	..	..	140000	..	64000	..	24000	..					
MTD-AVG.		26	7900	5400	..	2500	..	950	..	1200					

PROVISIONAL:

Subject to Revision

7311800

SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

MONTHLY AND ANNUAL MEANS AND LOADS FOR OCTOBER 1971 TO SEPTEMBER 1972

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE		DIS- SOLVED SOLIDS		DIS- SOLVED CHLORIDE		DIS- SOLVED CHLORIDE		DIS- SOLVED SULFATE		DIS- SOLVED SULFATE		HARDNESS (CA, MG)	
		(MICRO MHOS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(CA, MG)	(MG/L)
OCT. 1971	2478	5770	4700	31000	2000	14000	1000	5700	1200						
NOV. 1971	581	20300	14000	22000	6400	10000	2500	3900	3100						
DEC. 1971	662	17400	12000	22000	5500	9800	2200	4000	2700						
JAN. 1972	254	22900	16000	11000	7400	5100	2700	1800	3100						
FEB. 1972	225	27100	19000	11000	8900	5400	2900	1800	3200						
MAR. 1972	196	32400	22000	12000	11000	5800	3100	1600	4100						
APR. 1972	4736	2300	1600	20000	690	8800	340	4300	390						
MAY 1972	1915	4740	3300	17000	1400	7300	700	3600	810						
JUNE 1972	1476	6510	4500	18000	1900	7700	960	3800	1100						
JULY 1972	1575	4960	3400	15000	1500	6300	740	3100	850						
AUG. 1972	4346	3820	2600	31000	1100	13000	600	7000	680						
SEPT 1972	4777	2940	2000	26000	860	11000	450	5800	510						
TOTAL	23222	..	..	240000	..	100000	..	48000	..						
WTD-AVG.	63	5440	3800	..	1700	..	760	..	300						

PROVISIONAL

Subject to Revision

7311800

SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

MONTHLY AND ANNUAL MEANS AND LOADS FOR OCTOBER 1972 TO SEPTEMBER 1973

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC							
		CONDUCT- ANCE	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG)
OCT. 1972	2526	4460	3100	21000	1300	9100	650	4400	760
NOV. 1972	930	11400	7900	20000	3500	8700	1600	4000	1300
DEC. 1972	373	28500	14000	14000	6500	6600	2500	2500	3200
JAN. 1973	585	15800	11000	17000	4900	7700	2100	3300	2500
FEB. 1973	677	15300	11000	19000	4700	8600	2100	3800	2300
MAR. 1973	1972	8770	6100	32000	2600	14000	1300	6900	1500
APR. 1973	1613	9630	6700	29000	2900	13000	1400	6100	1500
MAY 1973	439	10800	13000	15000	5900	7000	2400	2800	2300
JUNE 1973	200	21400	15000	8000	6900	3700	2600	1400	3300
JULY 1973	470	5560	3800	4900	1700	2100	820	1000	950
AUG. 1973	167	9120	6300	2800	2800	1300	1200	550	1300
SEPT 1973	1905	5010	3500	18000	1500	7800	700	3600	930
TOTAL	11856	**	**	200000	**	89000	**	40000	**
WTD-AVG.	32	9130	6300	**	2800	**	1300	**	1300

PROVISIONAL

Subject to Revision

7311800

SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

MONTHLY AND ANNUAL MEANS AND LOADS FOR OCTOBER 1973 TO SEPTEMBER 1974

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE		DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA MG)
		(MICRO MHOS)	(MG/L)							
OCT. 1973	229	21100	15000	9000	9000	6800	4200	2400	1500	3100
NOV. 1973	607	13300	9200	15000	15000	4200	6900	1600	2700	2000
DEC. 1973	184	29000	20000	9900	9900	9700	4800	3000	1500	4100
JAN. 1974	145	31300	21000	8400	8400	11000	4100	3100	1200	4300
FEB. 1974	130	34600	24000	8300	8300	12000	4200	3200	1100	4500
MAR. 1974	150	35800	25000	10000	10000	12000	5000	3200	1300	4500
APR. 1974	459	10900	7500	9200	9200	3600	4500	1100	1400	1300
MAY 1974	947	8020	5500	14000	14000	2400	6300	1100	2900	1300
JUNE 1974	2351	4560	3200	20000	20000	1300	8600	690	4400	790
JULY 1974	12	19900	14000	430	430	6300	200	2500	70	3100
AUG. 1974	66	5430	3800	670	670	1600	280	830	150	350
SEPT 1974	3634	3300	2300	22000	22000	960	3400	520	5100	590
TOTAL	8915	**	**	130000	**	**	58000	**	23000	**
WTD.AVG.	24	7690	5300	**	**	2400	**	970	**	1200

PROVISIONAL

Subject to Revision

7311800 SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

MONTHLY AND ANNUAL MEANS AND LOADS FOR OCTOBER 1974 TO SEPTEMBER 1975

MONTH YEAR	SPECIFIC CONDUCTANCE		DIS- SOLVED SOLIDS (MG/L)		DIS- SOLVED CHLORIDE (MG/L)		DIS- SOLVED CHLORIDE (TONS)		DIS- SOLVED SULFATE (MG/L)		DIS- SOLVED SULFATE (TONS)		HAZINESS (CA, MG)	
	DISCHARGE (CFS-DAYS)	(MICRO MHOS)	SOLIDS (MG/L)	(TONS)	CHLORIDE (MG/L)	(TONS)	CHLORIDE (TONS)	(MG/L)	SULFATE (MG/L)	(TONS)	SULFATE (MG/L)	(TONS)	(CA, MG)	(MG/L)
OCT. 1974	1342	8550	5900	21000	2600	9400	9400	1200	4300	4300	1100	1100		
NOV. 1974	542	16800	12000	17000	5200	7700	7700	2200	3200	3200	2700	2700		
DEC. 1974	288	25700	18000	14000	8400	6500	6500	2900	2200	2200	3700	3700		
JAN. 1975	301	24700	17000	14000	8100	6500	6500	2800	2300	2300	3600	3600		
FEB. 1975	762	11900	8200	17000	3600	7400	7400	1600	3400	3400	2800	2800		
MAR. 1975	313	23500	16000	14000	7600	6400	6400	2700	2300	2300	3500	3500		
APR. 1975	509	12800	8800	12000	4000	5500	5500	1600	2300	2300	2800	2800		
MAY 1975	7012	3130	2200	41000	910	17000	17000	500	9400	9400	560	560		
JUNE 1975	2277	6090	4800	29000	2100	13000	13000	1000	6300	6300	1200	1200		
JULY 1975	3859	4630	3200	33000	1400	14000	14000	710	7400	7400	810	810		
AUG. 1975	1296	7840	5400	19000	2400	9300	9300	1100	3900	3900	1300	1300		
SEPT 1975	2252	5990	4100	25000	1800	11000	11000	900	5500	5500	1000	1000		
TOTAL	20753	**	**	260000	**	110000	110000	**	52000	52000	**	**		
WTD-AVG.	57	6630	4600	**	2000	**	**	940	**	**	1100	1100		

PROVISIONAL
Subject to Revision

SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

MONTHLY AND ANNUAL MEANS AND LOADS FOR OCTOBER 1975 TO SEPTEMBER 1976

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCTANCE												HARDNESS (CA, MG) (46/L)
		DIS- SOLIDS (MG/L)	DIS- SOLIDS (TONS)	DIS- CHLORIDE (MG/L)	DIS- CHLORIDE (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)			
OCT. 1975	318	20300	14000	12000	6400	5500	2500	2100	3100					
NOV. 1975	1412	8450	5800	22000	2500	9700	1200	4600	1100					
DEC. 1975	285	23900	16000	13000	7700	5900	2800	2100	3500					
JAN. 1976	246	24600	17000	11000	8000	5300	2800	1900	3600					
FEB. 1976	245	28500	20000	13000	9400	6200	3000	2000	4000					
MAR. 1976	269	29900	21000	15000	10000	7300	3000	2200	4200					
APR. 1976	826	14800	10000	23000	4600	10000	1900	4200	2300					
MAY 1976	231	25700	18000	11000	8400	5300	2800	1800	3700					
JUNE 1976	45	24500	17000	2000	8100	970	2600	320	3500					
JULY 1976	512	7540	5200	7200	2200	3100	1100	1600	1300					
AUG. 1976	1140	5370	3700	11000	1600	4900	830	2500	940					
SEPT 1976	771	12900	8900	19000	3900	8200	1800	3700	2100					
TOTAL	6299	**	**	160000	**	73000	**	29000	**					
MTD. AVG.	17	13600	9300	**	4300	**	1700	**	2100					

PROVISIONAL

Subject to Revision

APPENDIX C

SOUTH WICHITA RIVER NEAR GUTHRIE, TEXAS
MONTHLY AND ANNUAL MEANS AND LOADS
FOR OCTOBER 1970 TO SEPTEMBER 1976

7311780 SOUTH WICHITA RIVER NEAR GUTHRIE, TX. (DISC)

MONTHLY AND ANNUAL MEANS AND LOADS FOR OCTOBER 1970 TO SEPTEMBER 1971

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCTANCE										DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA+MG)
		(MICRO MHOS)	(MG/L)	SOLIDS (TONS)	SOLVED CHLORIDE (MG/L)	SOLVED CHLORIDE (TONS)	SOLVED SULFATE (MG/L)	SOLVED SULFATE (TONS)	SOLVED CHLORIDE (MG/L)	SOLVED CHLORIDE (TONS)	SOLVED SULFATE (MG/L)					
OCT. 1970	91	41700	29000	7200	15000	3600	3600	890	4700							
NOV. 1970	84	41100	29000	6500	14000	3200	3600	810	4500							
DEC. 1970	88	42100	29000	6900	15000	3500	3600	860	4700							
JAN. 1971	97	41900	29000	7600	15000	3800	3600	950	4700							
FEB. 1971	79	40600	28000	6000	14000	3000	3600	760	4500							
MAR. 1971	90	43400	30000	7300	15000	3700	3700	900	4300							
APR. 1971	83	43800	31000	6800	15000	3400	3700	840	4300							
MAY 1971	96	41000	28000	7300	14000	3700	3600	920	4500							
JUNE 1971	87	37400	26000	6100	13000	3000	3300	780	4100							
JULY 1971	71	45300	32000	6100	16000	3100	3800	730	5100							
AUG. 1971	1284	6670	4400	15000	2100	7300	680	2400	690							
SEPT 1971	138	34500	24000	8800	12000	4400	3100	1200	3300							
TOTAL	2287	..	..	92000	..	45000	..	12000	..							
WTD.AVG.	6.3	21600	15000	..	7400	..	1900	..	2100							

PROVISIONAL

Subject to Revision

7311780

SOUTH WICHITA RIVER NEAR GUTHRIE, TX. (DISC)

MONTHLY AND ANNUAL MEANS AND LOADS FOR OCTOBER 1971 TO SEPTEMBER 1972

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCTANCE				DIS- SOLVED SOLIDS		DIS- SOLVED CHLORIDE		DIS- SOLVED CHLORIDE		DIS- SOLVED SULFATE		DIS- SOLVED SULFATE		HARDNESS (CA, MG) (46/L)
		(MICRO MHOS)	(MG/L)	(TONS)	(MG/L)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	
OCT. 1971	279	25300	17000	13000	8300	6200	2400	1800	2700							
NOV. 1971	175	32300	22000	10000	11000	5100	3000	1400	3500							
DEC. 1971	174	32600	22000	10000	11000	5100	3000	1400	3500							
JAN. 1972	154	35100	24000	10000	12000	4900	3200	1300	3900							
FEB. 1972	125	37100	25000	8600	13000	4300	3300	1100	4100							
MAR. 1972	142	40300	28000	11000	14000	5400	3500	1400	4500							
APR. 1972	120	40100	28000	9000	14000	4500	3500	1100	4500							
MAY 1972	131	40700	28000	10000	14000	5000	3600	1300	4500							
JUNE 1972	162	31900	22000	9500	11000	4700	2900	1300	3500							
JULY 1972	127	43400	30000	10000	15000	5200	3700	1300	4900							
AUG. 1972	226	26300	18000	11000	8900	5400	2400	1500	2900							
SEPT 1972	168	30700	21000	9400	10000	4600	2900	1300	3100							
TOTAL	1984	**	**	120000	**	61000	**	16000	**							
WTD.AVG.	5.4	33300	23000	**	11000	**	3000	**	3500							

PROVISIONAL

Subject to Revision

7311780 SOUTH WICHITA RIVER NEAR GUTHRIE, TX. (DISC)

MONTHLY AND ANNUAL MEANS AND LOADS FOR OCTOBER 1972 TO SEPTEMBER 1973

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCTANCE								DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG)
		(MICRO MHOS)	DIS- SOLIDS (MG/L)	DIS- SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	DIS- SOLVED SULFATE (MG/L)						
OCT. 1972	153	33100	23000	9300	11000	4600	3100	1300	3500						
NOV. 1972	152	33600	23000	9400	11000	4600	3100	1300	3600						
DEC. 1972	152	35700	24000	10000	12000	5000	3200	1300	3900						
JAN. 1973	156	35300	24000	10000	12000	5000	3200	1400	3900						
FEB. 1973	134	36400	25000	9000	12000	4500	3300	1200	4000						
MAR. 1973	242	28600	19000	13000	9500	6200	2700	1800	3100						
APR. 1973	164	33300	23000	10000	11000	5000	3100	1400	3500						
MAY 1973	148	35100	24000	9600	12000	4800	3200	1300	3800						
JUNE 1973	143	37700	26000	10000	13000	5000	3400	1300	4100						
JULY 1973	161	41200	29000	12000	14000	6200	3600	1600	4500						
AUG. 1973	192	37800	26000	14000	13000	6800	3400	1700	4200						
SEPT 1973	192	36100	25000	13000	12000	6400	3300	1700	4000						
TOTAL	1988	**	**	130000	**	64000	**	17000	**						
WTD.AVG.	5.4	35100	24000	**	12000	**	3200	**	3900						

PROVISIONAL

Subject to Revision

7311780

SOUTH WICHITA RIVER NEAR GUTHRIE, TX. (DISC)

MONTHLY AND ANNUAL MEANS AND LOADS FOR OCTOBER 1973 TO SEPTEMBER 1974

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE				DIS- SOLVED SOLIDS		DIS- SOLVED CHLORIDE		DIS- SOLVED CHLORIDE		DIS- SOLVED SULFATE		HARDNESS	
		(MICRO MHOS)	SOLIDS (MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(CA, MG)	(MG/L)	
OCT. 1973	180	38400	26000	13000	13000	6400	3400	1700	4200						
NOV. 1973	122	37700	26000	8600	13000	4300	3400	1100	4200						
DEC. 1973	130	37900	26000	9200	13000	4600	3400	1200	4200						
JAN. 1974	133	39800	27000	9900	14000	4900	3500	1300	4100						
FEB. 1974	116	40300	28000	8700	14000	4400	3500	1100	4300						
MAR. 1974	140	41000	28000	11000	14000	5400	3600	1300	4500						
APR. 1974	134	42600	30000	11000	15000	5400	3700	1300	4900						
MAY 1974	152	40200	28000	11000	14000	5700	3500	1400	4500						
JUNE 1974	305	21000	14000	12000	6900	5700	2000	1700	2200						
JULY 1974	105	43700	31000	8600	15000	4400	3700	1100	4300						
AUG. 1974	98	43200	30000	8000	15000	4000	3700	980	4900						
SEPT 1974	156	32200	22000	9300	11000	4600	2900	1200	3500						
TOTAL	1771	**	**	120000	**	60000	**	15000	**						
WTD.AVG.	4.9	36300	25000	**	12000	**	3200	**	4900						

PROVISIONAL

Subject to Revision

7311780 SOUTH WICHITA RIVER NEAR GUTHRIE, TX. (DISC)

MONTHLY AND ANNUAL MEANS AND LOADS FOR OCTOBER 1974 TO SEPTEMBER 1975

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCTANCE				DIS- SOLVED SOLIDS		DIS- SOLVED CHLORIDE		DIS- SOLVED CHLORIDE		DIS- SOLVED SULFATE		DIS- SOLVED SULFATE		HARDNESS (CA, MG) (MG/L)
		(MICRO MHOS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	
OCT. 1974	179	30600	21000	10000	10000	5000	2800	1400	3300							
NOV. 1974	140	33100	23000	8500	11000	4200	3100	1200	3500							
DEC. 1974	142	35500	24000	9300	12000	4600	3200	1200	3900							
JAN. 1975	130	37300	26000	9000	13000	4500	3400	1200	4100							
FEB. 1975	112	36700	25000	7700	13000	3800	3300	1000	4000							
MAR. 1975	144	39300	27000	11000	14000	5300	3500	1400	4100							
APR. 1975	107	39900	28000	8000	14000	4000	3500	1000	4100							
MAY 1975	441	17400	12000	14000	5600	6600	1700	2100	1900							
JUNE 1975	134	27400	18000	6600	9000	3200	2600	960	2300							
JULY 1975	180	26900	18000	8900	9000	4400	2500	1200	2900							
AUG. 1975	164	32800	22000	9900	11000	4900	3000	1400	3500							
SEPT 1975	144	33800	23000	8900	11000	4400	3100	1200	3700							
TOTAL	2018	**	**	110000	**	55000	**	15000	**							
WID. AVG.	5.5	30000	20000	**	10000	**	2800	**	3200							

PROVISIONAL

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MONTHLY AND ANNUAL MEANS AND LOADS FOR OCTOBER 1975 TO SEPTEMBER 1976

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCTANCE				DIS- SOLVED CHLORIDE				DIS- SOLVED CHLORIDE				DIS- SOLVED SULFATE				DIS- SOLVED SULFATE				HARDNESS			
		(MICRO MHOS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(MG/L)	(TONS)	(CA, MG)	(MG/L)	(TONS)	(CA, MG)	(MG/L)		
OCT. 1975	127	36700	25000	8700	13000	4300	3300	1100	4000																
NOV. 1975	108	36900	25000	7400	13000	3700	3300	970	4100																
DEC. 1975	116	38200	26000	8200	13000	4100	3400	1100	4200																
JAN. 1976	96	39800	28000	7200	14000	3600	3500	910	4100																
FEB. 1976	83	40900	28000	6400	14000	3200	3600	800	4500																
MAR. 1976	123	41900	29000	9700	15000	4900	3600	1200	4700																
APR. 1976	139	39900	28000	10000	14000	5200	3500	1300	4100																
MAY 1976	135	41700	29000	11000	15000	5300	3600	1300	4700																
JUNE 1976	111	43900	31000	9200	15000	4600	3700	1100	4300																
JULY 1976	144	39600	27000	11000	14000	5300	3500	1300	4400																
AUG. 1976	145	29800	20000	8000	10000	3900	2700	1100	3200																
SEPT 1976	131	35400	24000	8600	12000	4300	3200	1100	3300																
TOTAL	1460	**	**	110000	**	52000	**	13000	**																
WTD.AVG.	4.0	38500	27000	**	13000	**	3400	**	4300																

PROVISIONAL

Subject to Revision

APPENDIX D

SOUTH WICHITA RIVER AT LOW FLOW DAM NEAR GUTHRIE, TEXAS
(STATION NOS. 7311782 AND 7311783)
DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTHS
MAY 1987 - APR 1988

7311782 SOUTH WICHITA RIVER AT LOW FLOW DAM NR GUTHRIE,
DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF MAY 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHDS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA.MG) (MG/L)
MAY 1987									
1	7.1	32700	22000	426	11000	210	3000	58	**
2	7.1	32700	22000	426	11000	210	3000	58	**
3	7.1	32700	22000	426	11000	210	3000	58	**
4	0.8	32700	22000	49	11000	24	3000	6.7	**
5	6.2	32700	22000	371	11000	183	3000	51	**
6	0.00	--	--	--	--	--	--	--	--
7	2.9	33400	23000	177	11000	87	3100	24	**
8	6.9	33200	23000	423	11000	209	3100	58	**
9	6.7	33200	23000	409	11000	202	3100	56	**
10	6.7	32900	22000	405	11000	200	3100	55	**
11	6.7	32800	22000	403	11000	199	3100	55	**
12	7.0	33300	23000	428	11000	211	3100	58	**
13	5.2	32900	22000	312	11000	154	3100	43	**
14	7.1	33500	23000	435	11000	215	3100	59	**
15	6.7	33500	23000	414	11000	204	3100	56	**
16	7.4	33100	23000	447	11000	220	3100	61	**
17	7.9	32900	22000	478	11000	236	3100	65	**
18	5.5	30800	21000	312	10000	153	2900	44	**
19	7.0	30100	20000	382	10000	187	2900	54	**
20	10	30400	21000	571	10000	280	2900	80	**
21	7.8	32800	22000	468	11000	231	3100	64	**
22	2.1	31100	21000	120	10000	59	2900	17	**
23	7.1	26900	18000	343	8800	167	2600	50	**
24	9.4	26200	18000	445	8500	217	2600	65	**
25	13	22200	15000	512	7100	247	2200	78	**
26	13	24000	16000	556	7700	269	2400	83	**
27	1.7	25700	17000	78	8300	38	2500	11	**
28	0.00	--	--	--	--	--	--	--	--
29	0.00	--	--	--	--	--	--	--	--
30	0.00	--	--	--	--	--	--	--	--
31	0.01	7820	5000	0.1	2300	0.06	870	0.02	770
TOTAL	176	**	**	9800	**	4800	**	1400	**
MTD. AVG.	5.7	30500	21000	**	10000	**	2900	**	3300

7311722

SOUTH WICHITA RIVER AT LOW FLOW DAM NR GUTHRIE,

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF JUNE 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
JUNE 1987									
1	2.9	12600	8100	85	3800	40	1400	14	**
2	5.4	13000	8400	122	4000	58	1400	20	**
3	8.5	14500	9400	216	4500	102	1500	35	**
4	14	15700	10000	375	4900	178	1600	61	**
5	14	16800	11000	403	5200	192	1800	64	**
6	14	17400	11000	418	5400	199	1800	66	**
7	13	18200	12000	422	5700	202	1900	66	**
8	14	18900	12000	452	5900	217	1900	71	**
9	13	19200	13000	466	6200	224	2000	73	**
10	11	20100	13000	383	5400	184	2000	59	**
11	3.3	16900	11000	98	5300	47	1800	16	**
12	11	13400	8700	256	4100	121	1400	42	**
13	13	13500	8500	304	4100	144	1400	50	**
14	13	14200	9200	326	4400	154	1500	53	**
15	12	15200	9900	313	4700	149	1600	51	**
16	13	16200	11000	382	5000	182	1700	61	**
17	12	17200	11000	356	5400	170	1800	57	**
18	7.8	18100	12000	250	5700	120	1900	39	**
19	11	19100	13000	371	6000	178	2000	58	**
20	8.6	20100	13000	307	6400	148	2000	48	**
21	13	21100	14000	489	6700	235	2100	75	**
22	13	22100	15000	513	7100	248	2200	78	**
23	13	22900	15000	541	7300	261	2300	82	**
24	13	24200	16000	578	7800	280	2400	86	**
25	9.5	23700	16000	402	7600	194	2400	60	**
26	13	24500	16000	579	7900	281	2400	86	**
27	11	24900	17000	485	8100	235	2500	72	**
28	8.8	25200	17000	401	8200	195	2500	59	**
29	11	25600	17000	501	8300	244	2500	74	**
30	13	23600	16000	546	7600	264	2300	82	**
TOTAL	332	**	**	11000	**	5400	**	1800	**
WTD. AVG.	11	19200	13000	**	6100	**	2000	**	2000

7311782

SOUTH WICHITA RIVER AT LOW FLOW DAM NR GUTHRIE,

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF JULY 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
JULY 1987									
1	8.6	25000	17000	385	8100	187	2500	57	**
2	12	25100	17000	539	8100	262	2500	80	**
3	10	25400	17000	471	8200	229	2500	69	**
4	9.7	26600	18000	464	8700	226	2600	68	**
5	11	28200	19000	587	9300	287	2700	84	**
6	3.8	27400	18000	187	9000	91	2700	27	**
7	0.00	--	--	--	--	--	--	--	--
8	0.2	27200	18000	9.4	8900	4.6	2600	1.4	**
9	0.00	--	--	--	--	--	--	--	--
10	3.1	28800	19000	160	9500	78	2800	23	**
11	12	28700	19000	638	9400	312	2800	91	**
12	12	30700	21000	693	10000	340	2900	97	**
13	6.7	29300	20000	357	9700	175	2800	51	**
14	13	28600	19000	661	9400	323	2700	94	**
15	7.2	28400	19000	371	9300	181	2700	53	**
16	10	28000	19000	517	9200	252	2700	74	**
17	7.3	28400	19000	376	9300	184	2700	54	**
18	0.00	--	--	--	--	--	--	--	--
19	0.00	--	--	--	--	--	--	--	--
20	7.9	16500	11000	229	5100	109	1700	37	**
21	13	18400	12000	436	5800	209	1900	69	**
22	13	21600	14000	516	6900	249	2200	79	**
23	13	26200	18000	611	8500	297	2600	89	**
24	7.5	27400	18000	371	9000	181	2700	54	**
25	8.3	26000	17000	389	8500	189	2500	57	**
26	13	27400	18000	635	9000	310	2700	92	**
27	12	27800	19000	589	9100	288	2700	85	**
28	10	28400	19000	518	9300	253	2700	74	**
29	7.8	28600	19000	405	9400	198	2700	58	**
30	7.8	29000	20000	411	9600	201	2800	58	**
31	7.8	28500	19000	404	9400	197	2700	58	**
TOTAL	249	**	**	12000	**	5800	**	1700	**
WTD. AVG.	8.0	26500	18000	**	8600	**	2600	**	2800

7311782 SOUTH WICHITA RIVER AT LOW FLOW DAM NR GUTHRIE,

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF AUG. 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLIDS (MG/L)	DIS- SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
AUG. 1987									
1	7.8	28900	19000	410	9500	200	2800	58	**
2	7.8	29700	20000	422	9800	207	2800	60	**
3	7.7	30500	21000	427	10000	210	2900	60	**
4	7.4	31300	21000	424	10000	208	2900	59	**
5	7.4	31500	21000	426	10000	210	3000	59	**
6	8.2	29700	20000	442	9800	217	2800	62	**
7	3.5	29100	20000	186	9600	91	2800	26	**
8	0.00	--	--	--	--	--	--	--	--
9	0.00	--	--	--	--	--	--	--	--
10	0.00	--	--	--	--	--	--	--	--
11	7.7	31000	21000	435	10000	214	2900	61	**
12	14	31000	21000	770	10000	378	2900	107	**
13	9.2	31100	21000	521	10000	256	2900	73	**
14	6.9	31300	21000	392	10000	193	2900	54	**
15	2.9	31800	22000	171	11000	84	3000	24	**
16	9.3	31600	21000	535	11000	263	3000	74	**
17	10	31500	21000	577	10000	284	3000	80	**
18	7.8	31500	21000	449	10000	221	3000	62	**
19	7.8	31500	21000	449	10000	221	3000	62	**
20	7.8	31500	21000	449	10000	221	3000	62	**
21	7.8	31500	21000	449	10000	221	3000	62	**
22	7.8	31400	21000	448	10000	220	3000	62	**
23	7.2	31600	21000	413	11000	203	3000	57	**
24	3.9	31600	21000	223	11000	110	3000	31	**
25	7.1	31600	21000	411	11000	202	3000	57	**
26	3.2	31500	21000	182	10000	90	3000	25	**
27	8.8	31600	21000	508	11000	250	3000	70	**
28	13	31700	21000	764	11000	376	3000	106	**
29	12	29200	20000	650	9600	318	2800	92	**
30	7.8	28200	19000	399	9300	195	2700	57	**
31	7.8	31300	21000	446	10000	219	2900	62	**
TOTAL	219	**	**	12000	**	6100	**	1700	**
WTD. AVG.	7.1	30900	21000	**	10000	**	2900	**	3300

7311782 SOUTH WICHITA RIVER AT LOW FLOW DAM NR GUTHRIE,
DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF SEPT 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHDS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
SEPT 1987									
1	7.8	31400	21000	448	10000	220	3000	62	**
2	7.8	31500	21000	449	10000	221	3000	62	**
3	7.8	31700	21000	453	11000	223	3000	63	**
4	7.3	30500	21000	405	10000	199	2900	57	**
5	7.1	30200	20000	391	10000	192	2900	55	**
6	7.1	29700	20000	384	9800	188	2800	54	**
7	6.5	31500	21000	375	10000	185	3000	52	**
8	7.1	31400	21000	408	10000	201	3000	57	**
9	9.3	31500	21000	534	10000	263	3000	74	**
10	7.8	31500	21000	449	10000	221	3000	62	**
11	7.8	31500	21000	449	10000	221	3000	62	**
12	7.4	31400	21000	425	10000	209	3000	59	**
13	7.9	31300	21000	452	10000	222	2900	63	**
14	7.8	31200	21000	445	10000	219	2900	62	**
15	13	29500	20000	671	9700	329	2800	95	**
16	8.7	31300	21000	495	10000	243	2900	69	**
17	7.8	31200	21000	445	10000	219	2900	62	**
18	7.8	31100	21000	443	10000	218	2900	62	**
19	7.8	31000	21000	442	10000	217	2900	62	**
20	7.8	31200	21000	443	10000	218	2900	62	**
21	7.8	31200	21000	445	10000	219	2900	62	**
22	7.8	31300	21000	446	10000	219	2900	62	**
23	7.8	31400	21000	448	10000	220	3000	62	**
24	7.8	31500	21000	449	10000	221	3000	62	**
25	7.8	31500	21000	449	10000	221	3000	62	**
26	7.8	31600	21000	451	11000	222	3000	62	**
27	6.2	31600	21000	357	11000	176	3000	49	**
28	7.4	31700	21000	427	11000	210	3000	59	**
29	7.1	31600	21000	411	11000	202	3000	57	**
30	7.1	31500	21000	409	10000	201	3000	57	**
TOTAL	233	**	**	13000	**	6500	**	1800	**
WTD. AVG.	7.8	31200	21000	**	10000	**	2900	**	3400

7311722

SOUTH WICHITA RIVER AT LOW FLOW DAM NR GUTHRIE,

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF OCT. 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
OCT. 1987									
1	7.0	31500	21000	400	10000	197	3000	56	**
2	6.5	31500	21000	375	10000	184	3000	52	**
3	7.1	31300	21000	406	10000	200	2900	56	**
4	7.1	31100	21000	404	10000	198	2900	56	**
5	7.1	31300	21000	406	10000	200	2900	56	**
6	7.1	31200	21000	405	10000	199	2900	56	**
7	7.1	31000	21000	400	10000	197	2900	56	**
8	7.2	31800	22000	417	11000	205	3000	58	**
9	7.4	32100	23000	438	11000	215	3000	60	**
10	7.4	31900	23000	435	11000	214	3000	60	**
11	7.4	31700	21000	431	11000	212	3000	60	**
12	7.4	32200	22000	438	11000	216	3000	60	**
13	7.4	32400	22000	440	11000	217	3000	60	**
14	7.4	32000	22000	433	11000	213	3000	60	**
15	7.2	32000	22000	420	11000	207	3000	58	**
16	7.5	32100	22000	440	11000	217	3000	61	**
17	7.5	32200	22000	443	11000	218	3000	61	**
18	4.6	32200	22000	271	11000	134	3000	37	**
19	0.3	32500	22000	15	11000	7.3	3000	2.0	**
20	7.6	32600	22000	452	11000	223	3000	62	**
21	10	32700	22000	605	11000	298	3000	83	**
22	7.0	32600	22000	417	11000	206	3000	57	**
23	6.9	32000	22000	402	11000	198	3000	55	**
24	7.0	31900	22000	408	11000	201	3000	56	**
25	7.0	32000	22000	409	11000	201	3000	56	**
26	6.9	32100	22000	408	11000	201	3000	56	**
27	6.9	32200	22000	408	11000	201	3000	56	**
28	6.9	31900	22000	404	11000	199	3000	56	**
29	6.9	32100	22000	407	11000	200	3000	56	**
30	7.0	32100	22000	412	11000	203	3000	57	**
31	7.0	32000	22000	410	11000	202	3000	57	**
TOTAL	215	**	**	13000	**	6200	**	1700	**
WTD. AVG.	6.9	31900	22000	**	11000	**	3000	**	3400

7311782 SOUTH WICHITA R AT LOW FLOW DAM NR GUTHRIE, TX.

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF NOV. 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLIDS (MG/L)	DIS- SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
NOV. 1987									
1	7.5	32300	22000	444	11000	219	3000	61	**
2	7.5	32300	22000	444	11000	219	3000	61	**
3	7.5	32400	22000	446	11000	220	3000	61	**
4	7.5	32700	22000	450	11000	222	3000	62	**
5	7.5	32800	22000	451	11000	223	3100	62	**
6	7.5	32800	22000	451	11000	223	3100	62	**
7	7.5	32800	22000	451	11000	223	3100	62	**
8	7.5	32700	22000	450	11000	222	3000	62	**
9	7.4	32400	22000	440	11000	217	3000	60	**
10	6.6	32900	22000	399	11000	197	3100	55	**
11	7.4	33200	23000	451	11000	223	3100	62	**
12	7.4	32300	22000	438	11000	216	3000	60	**
13	7.4	32100	22000	435	11000	214	3000	60	**
14	7.4	32000	22000	434	11000	214	3000	60	**
15	7.4	32100	22000	435	11000	214	3000	60	**
16	7.4	32300	22000	438	11000	216	3000	60	**
17	7.3	32500	22000	435	11000	214	3000	60	**
18	7.4	32900	22000	447	11000	220	3100	61	**
19	7.3	33100	23000	444	11000	219	3100	61	**
20	7.3	32900	22000	441	11000	217	3100	60	**
21	7.3	32300	22000	432	11000	213	3000	59	**
22	7.3	32500	22000	435	11000	214	3000	60	**
23	7.3	32500	22000	435	11000	214	3000	60	**
24	7.3	32200	22000	431	11000	212	3000	59	**
25	7.3	31200	21000	416	10000	205	2700	58	**
26	6.2	29700	20000	335	9800	164	2800	47	**
27	6.9	31900	22000	403	11000	198	3000	56	**
28	6.9	32200	22000	407	11000	201	3000	56	**
29	6.9	31900	22000	403	11000	198	3000	56	**
30	6.9	31800	22000	402	11000	198	3000	56	**
TOTAL	218	**	**	13000	**	6400	**	1800	**
WTD. AVG.	7.3	32300	22000	**	11000	**	3000	**	3500

7311782

SOUTH WICHITA RIVER LOW FLOW DAM NR GUTHRIE, TX.

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF DEC. 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
DEC. 1987									
1	6.8	31600	21000	393	11000	193	3000	54	**
2	6.9	31500	21000	398	10000	196	3000	55	**
3	6.9	31400	21000	396	10000	195	3000	55	**
4	6.9	31100	21000	392	10000	193	2900	55	**
5	8.5	31400	21000	488	10000	240	3000	68	**
6	8.1	31700	21000	470	11000	231	3000	65	**
7	6.9	31300	21000	395	10000	194	2900	55	**
8	7.1	31800	22000	413	11000	203	3000	57	**
9	7.4	32100	22000	435	11000	214	3000	60	**
10	7.3	32000	22000	428	11000	211	3000	59	**
11	7.4	31900	22000	432	11000	213	3000	60	**
12	7.5	31800	22000	437	11000	215	3000	60	**
13	5.9	31700	21000	342	11000	168	3000	47	**
14	6.0	31600	21000	347	11000	171	3000	48	**
15	12	31500	21000	692	10000	340	3000	96	**
16	7.9	31400	21000	454	10000	223	3000	63	**
17	7.3	31500	21000	418	10000	205	2900	58	**
18	7.3	31200	21000	416	10000	205	2900	58	**
19	7.4	31100	21000	421	10000	207	2900	59	**
20	9.7	31000	21000	549	10000	270	2900	77	**
21	7.2	31000	21000	408	10000	200	2900	57	**
22	7.2	30900	21000	406	10000	200	2900	57	**
23	7.2	30900	21000	422	10000	207	2900	59	**
24	7.4	30300	20000	608	10000	298	2900	85	**
25	11	30700	21000	230	10000	113	2900	32	**
26	4.1	30500	21000	156	10000	76	2900	22	**
27	2.8	28900	19000	630	9500	308	2800	90	**
28	12	29200	20000	637	9600	312	2800	90	**
29	12	29600	20000	507	9800	248	2800	72	**
30	9.4	29600	20000	372	9800	182	2800	53	**
31	6.9	29600	20000	372	9800	182	2800	53	**
TOTAL	238.4	**	**	13000	**	6600	**	1900	**
WTD. AVG.	7.7	31000	21000	**	10000	**	2900	**	3300

7311782 SOUTH WICHITA R AT LOW FLOW DAM NR GUTHRIE, TX.

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF JAN. 1988

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLIDS (MG/L)	DIS- SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
JAN. 1988									
1	10	29800	20000	543	9900	266	2800	77	**
2	6.8	30200	20000	374	10000	184	2900	53	**
3	7.9	30200	20000	435	10000	213	2900	61	**
4	9.0	30200	20000	496	10000	243	2900	70	**
5	6.5	30100	20000	357	10000	175	2900	50	**
6	6.1	29900	20000	332	9900	163	2800	47	**
7	12	30300	20000	663	10000	325	2900	93	**
8	8.1	30100	20000	444	10000	218	2900	62	**
9	5.0	29300	20000	267	9700	131	2800	38	**
10	1.7	29100	20000	90	9600	44	2800	13	**
11	0.00	--	--	--	--	--	--	--	--
12	0.00	--	--	--	--	--	--	--	--
13	0.00	--	--	--	--	--	--	--	--
14	0.00	--	--	--	--	--	--	--	--
15	0.00	--	--	--	--	--	--	--	--
16	0.00	--	--	--	--	--	--	--	--
17	0.00	--	--	--	--	--	--	--	--
18	0.00	--	--	--	--	--	--	--	--
19	0.00	--	--	--	--	--	--	--	--
20	3.2	31000	21000	181	10000	89	2900	25	**
21	7.4	31300	21000	424	10000	208	2900	59	**
22	7.4	31400	21000	425	10000	209	3000	59	**
23	9.3	31400	21000	534	10000	263	3000	74	**
24	12	31600	21000	694	11000	341	3000	96	**
25	7.5	31200	21000	428	10000	210	2900	59	**
26	6.9	31400	21000	396	10000	195	3000	55	**
27	6.9	31500	21000	398	10000	196	3000	55	**
28	6.9	31800	22000	402	11000	198	3000	56	**
29	6.9	31800	22000	402	11000	198	3000	56	**
30	6.9	32100	22000	406	11000	200	3000	56	**
31	6.8	32100	22000	400	11000	197	3000	55	**
TOTAL	161.2	**	**	9100	**	4500	**	1300	**
WTD. AVG.	5.2	30900	21000	**	10000	**	2900	**	3300

7311782 SOUTH WICHITA R AT LOW FLOW DAM NR GUTHRIE, TX.

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF FEB. 1988

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
FEB. 1988									
1	7.9	32200	22000	466	11000	230	3000	64	**
2	8.6	31500	21000	496	10000	244	3000	69	**
3	7.6	32500	22000	453	11000	223	3000	62	**
4	7.6	32300	22000	450	11000	222	3000	62	**
5	7.6	32100	22000	447	11000	220	3000	62	**
6	7.6	31900	22000	444	11000	219	3000	61	**
7	7.6	32000	22000	445	11000	219	3000	61	**
8	7.5	31600	21000	434	11000	213	3000	60	**
9	5.7	31400	21000	327	10000	161	3000	45	**
10	7.6	31500	21000	438	10000	215	3000	61	**
11	9.0	31800	22000	524	11000	258	3000	72	**
12	7.6	31300	21000	435	10000	214	2900	60	**
13	7.5	31500	21000	429	10000	211	2900	60	**
14	7.5	31700	21000	435	11000	214	3000	60	**
15	7.5	32200	22000	443	11000	218	3000	61	**
16	9.7	31400	21000	557	10000	274	3000	77	**
17	7.9	31300	21000	452	10000	222	2900	63	**
18	3.7	32700	22000	222	11000	109	3000	30	**
19	0.00	--	--	--	--	--	--	--	--
20	2.4	33000	22000	145	11000	72	3100	20	**
21	7.4	33200	23000	451	11000	223	3100	62	**
22	6.6	33200	23000	403	11000	199	3100	55	**
23	7.5	33300	23000	459	11000	227	3100	63	**
24	9.6	33000	22000	582	11000	287	3100	79	**
25	12	32800	22000	722	11000	356	3100	99	**
26	9.0	32600	22000	542	11000	267	3100	74	**
27	7.3	32400	22000	441	11000	217	3100	60	**
28	7.3	32700	22000	438	11000	216	3000	60	**
29	7.3	32700	22000	438	11000	216	3000	60	**
TOTAL	212.1	**	**	13000	**	6200	**	1700	**
WTD. AVG.	7.3	32200	22000	**	11000	**	3000	**	3500

7311782 SOUTH WICHITA R AT LOW FLOW DAM NR GUTHRIE, TX.

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF MAR. 1988

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
MAR. 1988									
1	5.8	33000	22000	351	11000	173	3100	48	**
2	3.2	32800	22000	193	11000	95	3100	26	**
3	9.4	32400	22000	558	11000	275	3000	77	**
4	11	31400	21000	632	10000	311	3000	88	**
5	11	31200	21000	627	10000	308	2900	87	**
6	7.1	30700	21000	398	10000	195	2900	56	**
7	6.7	31100	21000	381	10000	187	2900	53	**
8	8.1	30800	21000	456	10000	224	2900	64	**
9	6.7	31100	21000	381	10000	187	2900	53	**
10	6.7	31700	21000	389	11000	191	3000	54	**
11	9.3	31400	21000	534	10000	263	3000	74	**
12	7.6	30600	21000	424	10000	208	2900	59	**
13	7.1	32200	22000	419	11000	206	3000	58	**
14	7.1	32800	22000	427	11000	211	3100	59	**
15	7.1	33000	22000	430	11000	212	3100	59	**
16	7.1	33300	23000	434	11000	214	3100	59	**
17	7.1	33600	23000	439	11000	217	3100	60	**
18	7.1	33600	23000	439	11000	217	3100	60	**
19	7.1	33600	23000	439	11000	217	3100	60	**
20	7.1	33700	23000	440	11000	217	3100	60	**
21	7.0	33700	23000	434	11000	214	3100	59	**
22	7.0	34300	23000	442	12000	219	3200	60	**
23	7.4	35000	24000	478	12000	237	3200	64	**
24	9.1	34900	24000	586	12000	290	3200	79	**
25	6.9	34200	23000	435	12000	215	3100	59	**
26	7.2	34400	23000	456	12000	226	3200	61	**
27	7.2	34600	24000	459	12000	227	3200	62	**
28	7.2	34700	24000	461	12000	228	3200	62	**
29	7.2	34900	24000	464	12000	230	3200	62	**
30	7.2	35000	24000	465	12000	230	3200	62	**
31	7.2	34700	24000	461	12000	228	3200	62	**
TOTAL	230	**	**	14000	**	6900	**	1900	**
WTD. AVG.	7.4	33000	22000	**	11000	**	3100	**	3600

7311782

SOUTH WICHITA R AT LOW FLOW DAM NR GUTHRIE, TX.

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF APR. 1988

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA.MG) (MG/L)
APR. 1988									
1	7.3	34400	23000	463	12000	229	3200	62	**
2	7.4	34100	23000	465	11000	230	3100	63	**
3	7.4	33800	23000	460	11000	227	3100	62	**
4	7.4	33600	23000	457	11000	226	3100	62	**
5	7.4	33500	23000	456	11000	225	3100	62	**
6	7.4	33500	23000	456	11000	225	3100	62	**
7	7.4	33400	23000	454	11000	224	3100	62	**
8	5.9	33400	23000	362	11000	179	3100	49	**
9	5.7	33200	23000	348	11000	172	3100	47	**
10	3.0	33500	23000	184	11000	91	3100	25	**
11	6.9	33200	23000	421	11000	208	3100	57	**
12	6.9	33200	23000	421	11000	208	3100	57	**
13	8.9	33100	23000	541	11000	267	3100	74	**
14	7.9	33100	23000	480	11000	237	3100	66	**
15	7.5	33000	22000	454	11000	224	3100	62	**
16	7.5	33000	22000	454	11000	224	3100	62	**
17	7.5	32900	22000	453	11000	223	3100	62	**
18	7.5	32900	22000	453	11000	223	3100	62	**
19	7.5	32800	22000	451	11000	223	3100	62	**
20	3.6	32800	22000	217	11000	107	3100	30	**
21	0.00	--	--	--	--	--	--	--	--
22	0.00	--	--	--	--	--	--	--	--
23	0.00	--	--	--	--	--	--	--	--
24	0.00	--	--	--	--	--	--	--	--
25	0.00	--	--	--	--	--	--	--	--
26	0.00	--	--	--	--	--	--	--	--
27	0.00	--	--	--	--	--	--	--	--
28	2.2	34100	23000	138	11000	68	3100	19	**
29	10	34500	24000	636	12000	315	3200	86	**
30	12	34500	24000	763	12000	378	3200	103	**
TOTAL	162.2	**	**	10000	**	4900	**	1400	**
WTD. AVG.	5.4	33500	23000	**	11000	**	3100	**	3600

7911753

FOOTH WICHITA RIVER BELOW LOW FLOW DAM NR GUTHR

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF MAY 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHDS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
MAY 1987									
1	0.03	29700	20000	1.6	9800	0.8	2800	0.2	**
2	0.04	30600	21000	2.2	10000	1.1	2900	0.3	**
3	0.03	30900	21000	1.7	10000	0.8	2900	0.2	**
4	0.04	30500	21000	2.2	10000	1.1	2900	0.3	**
5	0.03	31400	21000	1.7	10000	0.8	3000	0.2	**
6	0.03	29700	20000	1.6	9800	0.8	2800	0.2	**
7	0.4	31900	22000	22	11000	11	3000	3.0	**
8	0.05	34000	23000	3.1	11000	1.5	3100	0.4	**
9	0.05	33100	23000	3.0	11000	1.5	3100	0.4	**
10	0.05	32000	22000	3.5	11000	1.7	3000	0.5	**
11	0.05	31300	21000	3.4	10000	1.7	2900	0.5	**
12	0.05	31600	21000	3.5	11000	1.7	3000	0.5	**
13	0.07	31600	21000	4.0	11000	2.0	3000	0.6	**
14	0.08	31700	21000	4.6	11000	2.3	3000	0.6	**
15	0.08	31600	21000	4.6	11000	2.3	3000	0.6	**
16	0.08	31400	21000	4.6	10000	2.3	3000	0.6	**
17	0.1	31700	21000	5.8	11000	2.9	3000	0.8	**
18	0.1	30900	21000	5.6	10000	2.8	2900	0.8	**
19	0.1	28900	19000	5.3	9500	2.6	2800	0.7	**
20	0.09	29400	20000	4.8	9700	2.4	2800	0.7	**
21	0.08	30800	21000	4.5	10000	2.2	2900	0.6	**
22	0.09	25400	17000	4.1	8200	2.0	2500	0.6	**
23	6.7	23300	15000	280	7500	135	2300	42	**
24	6.4	25400	17000	293	8200	142	2500	43	**
25	0.1	25700	17000	6.0	8300	2.9	2500	0.9	**
26	0.1	26200	18000	5.7	8500	2.8	2600	0.8	**
27	112	21300	14000	4250	6800	2050	2200	651	**
28	1030	1150	720	2000	330	920	130	368	110
29	415	3530	2200	2490	1000	1150	400	449	340
30	52	6400	4100	576	1900	268	720	101	630
31	25	9250	5900	399	2800	187	1000	68	910
TOTAL	1649	**	**	10000	**	4900	**	1700	**
WTD. AVG.	53	3630	2300	**	1100	**	390	**	360

7311783

SOUTH WICHITA RIVER BELOW LOW FLOW DAM NR GUTHR

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF JUNE 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHDS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA.MG) (MG/L)
JUNE 1987									
1	9.3	11700	7500	189	3600	89	1300	32	**
2	8.3	12800	8300	185	3900	88	1400	31	**
3	8.5	13700	8900	204	4200	96	1500	33	**
4	3.8	15300	9900	102	4700	48	1600	17	**
5	2.6	16400	11000	75	5100	36	1700	12	**
6	1.0	17200	11000	29	5400	14	1800	4.7	**
7	0.4	18200	12000	13	5700	6.0	1900	2.0	**
8	0.2	19100	13000	7.8	6000	3.7	2000	1.2	**
9	0.3	19800	13000	9.5	6300	4.6	2000	1.5	**
10	12	20500	14000	438	6500	210	2100	68	**
11	11	15300	9900	295	4700	140	1600	48	**
12	6.4	14100	9100	158	4300	75	1500	26	**
13	4.9	14500	9400	124	4500	59	1500	20	**
14	5.7	16300	11000	163	5100	78	1700	26	**
15	2.5	16900	11000	74	5300	36	1800	12	**
16	1.2	17600	12000	37	5500	18	1800	5.9	**
17	0.5	19800	13000	19	6300	8.9	2000	2.9	**
18	5.0	20700	14000	184	6600	89	2100	28	**
19	0.1	21700	14000	4.3	6900	2.1	2200	0.6	**
20	4.4	22600	15000	178	7200	86	2300	27	**
21	0.1	23600	16000	5.1	7600	2.5	2300	0.8	**
22	0.1	24500	16000	4.8	7900	2.3	2400	0.7	**
23	0.1	25400	17000	5.9	8200	2.9	2500	0.9	**
24	0.1	26400	18000	6.7	8600	3.2	2600	1.0	**
25	0.3	24400	16000	14	7900	6.8	2400	2.1	**
26	0.2	24800	17000	8.0	8000	3.9	2400	1.2	**
27	0.2	24800	17000	8.5	8000	4.1	2400	1.3	**
28	0.2	24700	16000	8.4	8000	4.1	2400	1.3	**
29	1.5	22500	15000	61	7300	30	2300	9.3	**
30	0.3	19900	13000	9.5	6300	4.6	2000	1.5	**
TOTAL	91	**	**	2600	**	1300	**	420	**
WTD. AVG.	3.0	16300	11000	**	5100	**	1700	**	1700

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7311783 SOUTH WICHITA RIVER BELOW LOW FLOW DAM NR GUTHR

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF JULY 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHDS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA.MG) (MG/L)
JULY 1987									
1	0.2	20500	14000	7.0	6600	3.4	2100	1.1	**
2	0.2	21000	14000	6.7	6700	3.2	2100	1.0	**
3	0.2	21500	14000	6.1	6500	2.9	2200	0.9	**
4	0.1	24800	17000	6.2	8000	3.0	2400	0.9	**
5	0.1	27000	18000	6.8	8500	3.3	2600	1.0	**
6	0.1	26100	17000	6.1	8500	3.0	2600	0.9	**
7	1.8	25500	17000	83	8300	40	2500	12	**
8	7.5	26200	18000	355	8500	173	2600	52	**
9	7.5	26400	18000	358	8600	174	2600	52	**
10	6.3	27300	18000	311	8900	152	2600	45	**
11	0.1	27400	18000	6.9	9000	3.4	2700	1.0	**
12	0.1	28900	19000	6.3	9500	3.1	2800	0.9	**
13	0.2	26200	18000	9.0	8500	4.4	2600	1.3	**
14	0.1	27100	18000	5.9	8900	2.9	2600	0.9	**
15	0.1	28200	19000	5.1	9300	2.5	2700	0.7	**
16	0.8	25400	17000	37	8200	18	2500	5.5	**
17	28	18800	12000	932	5900	447	1900	146	**
18	26	11600	7500	524	3500	247	1300	88	**
19	5.6	13200	8500	129	4000	61	1400	21	**
20	1.8	14200	9200	45	4400	21	1500	7.3	**
21	0.2	16800	11000	4.4	5200	2.1	1800	0.7	**
22	0.1	20300	13000	4.3	6400	2.1	2100	0.7	**
23	0.09	22500	15000	3.6	7200	1.7	2300	0.5	**
24	0.08	23900	16000	3.4	7700	1.7	2400	0.5	**
25	0.07	25000	17000	3.1	8100	1.5	2500	0.5	**
26	0.07	25600	17000	3.2	8300	1.6	2500	0.5	**
27	0.06	26000	17000	2.8	8500	1.4	2500	0.4	**
28	0.06	26400	18000	2.9	8600	1.4	2600	0.4	**
29	0.06	26600	18000	2.9	8700	1.4	2600	0.4	**
30	0.06	26800	18000	2.9	8700	1.4	2600	0.4	**
31	0.07	27200	18000	3.4	8900	1.7	2600	0.5	**
TOTAL	88	**	**	2900	**	1400	**	450	**
WTD. AVG.	2.8	18500	12000	**	5800	**	1900	**	1900

7311723

SOUTH WICHITA RIVER BELOW LOW FLOW DAM NR GUTHR

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF AUG. 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
AUG. 1987									
1	0.09	27800	19000	4.5	9100	2.2	2700	0.7	**
2	0.09	28400	19000	4.6	9300	2.3	2700	0.7	**
3	0.08	29000	20000	4.2	9600	2.1	2800	0.6	**
4	0.06	29500	20000	3.2	9700	1.6	2800	0.5	**
5	0.06	29600	20000	3.2	9800	1.6	2800	0.5	**
6	0.07	29500	20000	3.8	9700	1.8	2800	0.5	**
7	0.06	29100	20000	3.2	9600	1.6	2800	0.5	**
8	0.06	28700	19000	3.1	9400	1.5	2800	0.4	**
9	4.1	30000	20000	224	9900	110	2800	32	**
10	6.5	31000	21000	368	10000	181	2700	51	**
11	6.6	31000	21000	374	10000	184	2700	52	**
12	3.6	31000	21000	204	10000	100	2700	28	**
13	0.1	30900	21000	5.6	10000	2.8	2700	0.8	**
14	0.09	31500	21000	5.2	10000	2.6	3000	0.7	**
15	0.08	30700	21000	4.5	10000	2.2	2700	0.6	**
16	0.08	30900	21000	4.5	10000	2.2	2700	0.6	**
17	0.08	30900	21000	4.5	10000	2.2	2700	0.6	**
18	0.08	30400	21000	4.4	10000	2.2	2700	0.6	**
19	0.08	30500	21000	4.5	10000	2.2	2700	0.6	**
20	0.1	30600	21000	5.6	10000	2.7	2700	0.8	**
21	0.08	30100	20000	4.4	10000	2.2	2700	0.6	**
22	0.07	29700	20000	3.8	9800	1.9	2800	0.5	**
23	0.05	29700	20000	2.7	9700	1.3	2800	0.4	**
24	0.05	29400	20000	2.7	9700	1.3	2800	0.4	**
25	0.06	29600	20000	3.2	9800	1.6	2800	0.5	**
26	0.06	29600	20000	3.2	9800	1.6	2800	0.5	**
27	0.8	26800	18000	37	8700	18	2600	5.3	**
28	0.08	25700	17000	3.7	8300	1.8	2500	0.5	**
29	0.09	25700	17000	4.2	8300	2.0	2500	0.6	**
30	0.09	26200	18000	4.3	8500	2.1	2600	0.6	**
31	0.08	27000	18000	3.9	8800	1.9	2600	0.6	**
TOTAL	24	**	**	1300	**	640	**	180	**
WTD. AVG.	0.8	30500	21000	**	10000	**	2700	**	3300

7311783 SOUTH WICHITA RIVER BELOW LOW FLOW DAM NR GUTHR
DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF SEPT 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
SEPT 1987									
1	0.08	26800	18000	3.9	8700	1.9	2600	0.6	**
2	0.07	28100	19000	3.6	9200	1.7	2700	0.5	**
3	0.08	27200	18000	3.9	8900	1.9	2600	0.6	**
4	0.09	25000	17000	4.0	8100	2.0	2500	0.6	**
5	0.08	24700	16000	3.6	8000	1.7	2400	0.5	**
6	0.09	23900	16000	3.9	7700	1.9	2400	0.6	**
7	0.07	26000	17000	3.3	8500	1.6	2500	0.5	**
8	0.06	26700	18000	2.9	8700	1.4	2600	0.4	**
9	0.07	27700	19000	3.5	9100	1.7	2700	0.5	**
10	0.08	28700	19000	4.2	9400	2.0	2800	0.6	**
11	0.06	28700	19000	3.1	9400	1.5	2800	0.4	**
12	0.08	27000	18000	3.9	8800	1.9	2600	0.6	**
13	0.08	27400	18000	4.0	9000	1.9	2700	0.6	**
14	0.06	26000	17000	2.8	8500	1.4	2500	0.4	**
15	0.06	26700	18000	2.9	8700	1.4	2600	0.4	**
16	0.06	27000	18000	2.9	8800	1.4	2600	0.4	**
17	0.06	27300	18000	3.0	8900	1.4	2600	0.4	**
18	0.05	27300	18000	2.5	8900	1.2	2600	0.4	**
19	0.06	27300	18000	3.0	8900	1.4	2600	0.4	**
20	0.06	27400	18000	3.0	9000	1.5	2700	0.4	**
21	0.06	27500	18000	3.0	9000	1.5	2700	0.4	**
22	0.06	27500	18000	3.0	9000	1.5	2700	0.4	**
23	0.05	27600	19000	2.5	9000	1.2	2700	0.4	**
24	0.05	27600	19000	2.5	9000	1.2	2700	0.4	**
25	0.05	27600	19000	2.5	9000	1.2	2700	0.4	**
26	0.05	27600	19000	2.5	9000	1.2	2700	0.4	**
27	0.05	27700	19000	2.5	9100	1.2	2700	0.4	**
28	0.05	27700	19000	2.5	9100	1.2	2700	0.4	**
29	0.05	27600	19000	2.5	9000	1.2	2700	0.4	**
30	0.05	27600	19000	2.5	9000	1.2	2700	0.4	**
TOTAL	1.9	**	**	94	**	46	**	14	**
WTD. AVG.	0.06	27000	18000	**	8800	**	2600	**	2900

7311783

SOUTH WICHITA RIVER BELOW LOW FLOW DAM NR GUTHR

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF OCT. 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
OCT. 1987									
1	0.06	27100	18000	2.9	8900	1.4	2600	0.4	**
2	0.05	27100	18000	2.5	8900	1.2	2600	0.4	**
3	0.06	27200	18000	3.0	8900	1.4	2600	0.4	**
4	0.07	27100	18000	3.4	8900	1.7	2600	0.5	**
5	0.05	27000	18000	2.4	8800	1.2	2600	0.4	**
6	0.05	27100	18000	2.5	8900	1.2	2600	0.4	**
7	0.06	27000	18000	2.9	8800	1.4	2600	0.4	**
8	0.06	27300	18000	3.0	8900	1.4	2600	0.4	**
9	0.06	27600	19000	3.0	9000	1.5	2700	0.4	**
10	0.05	27600	19000	2.5	9000	1.2	2700	0.4	**
11	0.05	27600	19000	2.5	9000	1.2	2700	0.4	**
12	0.06	27600	19000	3.0	9000	1.5	2700	0.4	**
13	0.06	27500	18000	3.0	9000	1.5	2700	0.4	**
14	0.06	27500	18000	3.0	9000	1.5	2700	0.4	**
15	0.05	27400	18000	2.5	9000	1.2	2700	0.4	**
16	0.04	27300	18000	2.0	8900	1.0	2600	0.3	**
17	0.04	27400	18000	2.0	9000	1.0	2700	0.3	**
18	0.05	27400	18000	2.5	9000	1.2	2700	0.4	**
19	0.04	27500	18000	2.0	9000	1.0	2700	0.3	**
20	0.04	27800	19000	2.0	9100	1.0	2700	0.3	**
21	0.06	27800	19000	3.0	9100	1.5	2700	0.4	**
22	0.06	27900	19000	3.0	9100	1.5	2700	0.4	**
23	0.05	27900	19000	2.5	9100	1.2	2700	0.4	**
24	0.06	27900	19000	3.0	9100	1.5	2700	0.4	**
25	0.06	27800	19000	3.0	9100	1.5	2700	0.4	**
26	0.06	27800	19000	3.0	9100	1.5	2700	0.4	**
27	0.07	27900	19000	3.5	9100	1.7	2700	0.5	**
28	0.06	28000	19000	3.0	9200	1.5	2700	0.4	**
29	0.06	28100	19000	3.1	9200	1.5	2700	0.4	**
30	0.08	28100	19000	4.1	9200	2.0	2700	0.6	**
31	0.06	28200	19000	3.1	9300	1.5	2700	0.4	**
TOTAL	1.7	**	**	87	**	42	**	13	**
WTD. AVG.	0.06	27600	19000	**	9000	**	2700	**	2900

7311783

SOUTH WICHITA R BLW LOW FLOW DAM NR GUTHRIE, TX

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF NOV. 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA. MG) (MG/L)
NOV. 1987									
1	0.06	28100	19000	3.1	9200	1.5	2700	0.44	**
2	0.07	28200	19000	3.6	9300	1.7	2700	0.51	**
3	0.07	28000	19000	3.6	9200	1.7	2700	0.51	**
4	0.06	27800	19000	3.0	9100	1.5	2700	0.43	**
5	0.05	27900	19000	2.5	9100	1.2	2700	0.36	**
6	0.05	28000	19000	2.5	9200	1.2	2700	0.36	**
7	0.06	28100	19000	3.1	9200	1.5	2700	0.44	**
8	0.06	28300	19000	3.1	9300	1.5	2700	0.44	**
9	0.05	28300	19000	2.6	9300	1.3	2700	0.37	**
10	0.05	28400	19000	2.6	9300	1.3	2700	0.37	**
11	0.05	28500	19000	2.6	9400	1.3	2700	0.37	**
12	0.05	28600	19000	2.6	9400	1.3	2700	0.37	**
13	0.05	28700	19000	2.6	9400	1.3	2800	0.37	**
14	0.05	28800	19000	2.6	9500	1.3	2800	0.37	**
15	0.04	28800	19000	2.1	9500	1.0	2800	0.30	**
16	0.05	29000	20000	2.6	9600	1.3	2800	0.37	**
17	0.04	29100	20000	2.1	9600	1.0	2800	0.30	**
18	0.04	29200	20000	2.1	9600	1.0	2800	0.30	**
19	0.05	29300	20000	2.7	9700	1.3	2800	0.38	**
20	0.04	29300	20000	2.1	9700	1.0	2800	0.30	**
21	0.04	29300	20000	2.1	9700	1.0	2800	0.30	**
22	0.04	29300	20000	2.1	9700	1.0	2800	0.30	**
23	0.04	29300	20000	2.1	9700	1.0	2800	0.30	**
24	0.04	29300	20000	2.1	9700	1.0	2800	0.30	**
25	0.03	29300	20000	1.6	9700	0.78	2800	0.23	**
26	0.04	29200	20000	2.1	9600	1.0	2800	0.30	**
27	0.03	29100	20000	1.6	9600	0.78	2800	0.23	**
28	0.03	29100	20000	1.6	9600	0.78	2800	0.23	**
29	0.03	29100	20000	1.6	9600	0.78	2800	0.23	**
30	0.04	29000	20000	2.1	9600	1.0	2800	0.30	**
TOTAL	1.4	**	**	73	**	36	**	10	**
WTD. AVG.	0.05	28700	19000	**	9400	**	2700	**	3100

7311763

SOUTH WICHITA R BLW LOW FLOW DAM NR GUTHRIE, TX

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF DEC. 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
DEC. 1987									
1	0.06	28900	19000	3.2	9500	1.5	2800	0.45	**
2	0.03	28900	19000	1.6	9500	0.77	2800	0.22	**
3	0.03	28900	19000	1.6	9500	0.77	2800	0.22	**
4	0.03	28900	19000	1.6	9500	0.77	2800	0.22	**
5	0.03	28800	19000	1.6	9500	0.77	2800	0.22	**
6	0.03	28800	19000	1.6	9500	0.77	2800	0.22	**
7	0.04	28700	19000	2.1	9400	1.0	2800	0.30	**
8	0.03	28500	19000	1.6	9400	0.76	2700	0.22	**
9	0.05	28200	19000	2.6	9300	1.2	2700	0.37	**
10	0.05	28300	19000	2.6	9300	1.3	2700	0.37	**
11	0.08	28200	19000	4.1	9300	2.0	2700	0.59	**
12	0.03	28200	19000	1.5	9300	0.75	2700	0.22	**
13	0.03	28000	19000	1.5	9200	0.74	2700	0.22	**
14	0.05	28000	19000	2.5	9200	1.2	2700	0.36	**
15	0.06	28000	19000	3.0	9200	1.5	2700	0.44	**
16	0.06	27900	19000	3.0	9100	1.5	2700	0.44	**
17	0.06	27800	19000	3.0	9100	1.5	2700	0.43	**
18	0.05	27700	19000	2.5	9100	1.2	2700	0.36	**
19	0.04	27600	19000	2.0	9000	0.98	2700	0.29	**
20	0.03	27500	18000	1.5	9000	0.73	2700	0.22	**
21	0.03	27600	19000	1.5	9000	0.73	2700	0.22	**
22	0.03	27700	19000	1.5	9100	0.74	2700	0.22	**
23	0.02	27900	19000	1.0	9100	0.49	2700	0.15	**
24	0.03	28000	19000	1.5	9200	0.74	2700	0.22	**
25	0.03	27900	19000	1.5	9100	0.74	2700	0.22	**
26	0.03	27900	19000	1.5	9100	0.74	2700	0.22	**
27	6.7	29400	20000	358	9700	176	2800	51	**
28	0.05	29500	20000	2.7	9700	1.3	2800	0.38	**
29	0.05	28900	19000	2.6	9500	1.3	2800	0.37	**
30	0.06	29500	20000	3.2	9700	1.6	2800	0.46	**
31	0.03	29900	20000	1.6	9900	0.80	2800	0.23	**
TOTAL	7.98	**	**	420	**	210	**	60	**
WTD. AVG.	0.26	29200	20000	**	9600	**	2800	**	3100

7311783

SOUTH WICHITA R BLW LOW FLOW DAM NR GUTHRIE, TX

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF JAN. 1988

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHDS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
JAN. 1988									
1	0.02	28600	19000	1.0	9400	0.51	2700	0.15	**
2	0.02	27900	19000	1.0	9100	0.49	2700	0.15	**
3	0.02	26100	17000	0.94	8500	0.46	2600	0.14	**
4	0.02	25800	17000	0.93	8400	0.45	2500	0.14	**
5	0.02	28400	19000	1.0	9300	0.50	2700	0.15	**
6	0.03	29700	20000	1.6	9800	0.80	2800	0.23	**
7	0.04	28800	19000	2.1	9500	1.0	2800	0.30	**
8	0.06	30000	20000	3.3	9900	1.6	2900	0.46	**
9	0.06	29700	20000	3.2	9800	1.6	2800	0.46	**
10	0.06	26800	18000	2.9	8700	1.4	2600	0.42	**
11	6.0	29400	20000	321	9700	157	2800	45	**
12	6.3	29200	20000	335	9600	164	2800	47	**
13	5.5	28200	19000	281	9300	137	2700	40	**
14	5.7	28100	19000	291	9200	142	2700	42	**
15	7.9	26800	18000	383	8700	186	2600	56	**
16	8.3	30100	20000	455	10000	223	2900	64	**
17	7.4	30300	20000	409	10000	201	2900	57	**
18	8.3	29500	20000	446	9700	218	2800	63	**
19	6.1	27300	18000	301	8900	147	2600	44	**
20	2.3	30300	20000	127	10000	62	2900	18	**
21	0.04	30600	21000	2.2	10000	1.1	2900	0.31	**
22	0.03	30800	21000	1.7	10000	0.83	2900	0.24	**
23	0.03	30100	20000	1.6	10000	0.81	2900	0.23	**
24	0.03	30300	20000	1.7	10000	0.81	2900	0.23	**
25	0.03	30000	20000	1.6	9900	0.80	2900	0.23	**
26	0.03	30200	20000	1.7	10000	0.81	2900	0.23	**
27	0.03	30200	20000	1.7	10000	0.81	2900	0.23	**
28	0.02	30200	20000	1.1	10000	0.54	2900	0.15	**
29	0.02	30200	20000	1.1	10000	0.54	2900	0.15	**
30	0.02	30300	20000	1.1	10000	0.54	2900	0.16	**
31	0.03	30200	20000	1.7	10000	0.81	2900	0.23	**
TOTAL	64.46	**	**	3400	**	1700	**	480	**
WTD. AVG.	2.1	28900	19000	**	9500	**	2800	**	3100

SOUTH WICHITA R BLW LOW FLOW DAM NR GUTHRIE, TX

7311723

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF FEB. 1983

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHDS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
1	0.03	30200	20000	1.7	10000	0.81	2900	0.23	**
2	0.03	30300	20000	1.7	10000	0.81	2900	0.23	**
3	0.03	30200	20000	1.7	10000	0.81	2900	0.23	**
4	0.03	30300	20000	1.7	10000	0.81	2900	0.23	**
5	0.03	30200	20000	1.7	10000	0.81	2900	0.23	**
6	0.03	30000	20000	1.6	9900	0.80	2900	0.23	**
7	0.03	29900	20000	1.6	9900	0.80	2800	0.23	**
8	0.03	29800	20000	1.6	9900	0.80	2800	0.23	**
9	0.03	29900	20000	1.6	9900	0.80	2800	0.23	**
10	0.03	29900	20000	1.6	9900	0.80	2800	0.23	**
11	0.03	30000	20000	1.6	9900	0.80	2900	0.23	**
12	0.03	30100	20000	1.6	10000	0.81	2900	0.23	**
13	0.03	30200	20000	1.7	10000	0.81	2900	0.23	**
14	0.03	30300	20000	1.7	10000	0.81	2900	0.23	**
15	0.03	30300	20000	1.7	10000	0.81	2900	0.23	**
16	0.03	30500	21000	1.7	10000	0.82	2900	0.23	**
17	0.03	30700	21000	1.7	10000	0.83	2900	0.24	**
18	0.03	30800	21000	1.7	10000	0.83	2900	0.24	**
19	0.03	30900	21000	1.7	10000	0.83	2900	0.24	**
20	3.4	33000	22000	206	11000	102	3100	28	**
21	0.03	32800	22000	1.8	11000	0.89	3100	0.25	**
22	0.03	32600	22000	1.8	11000	0.88	3000	0.25	**
23	0.03	32400	22000	1.8	11000	0.88	3000	0.25	**
24	0.03	32200	22000	1.8	11000	0.87	3000	0.24	**
25	0.03	32000	22000	1.8	11000	0.87	3000	0.24	**
26	0.03	31900	22000	1.8	11000	0.86	3000	0.24	**
27	0.03	31800	22000	1.7	11000	0.86	3000	0.24	**
28	0.03	31700	21000	1.7	11000	0.86	3000	0.24	**
29	0.03	31600	21000	1.7	11000	0.85	3000	0.24	**
TOTAL	4.24	**	**	250	**	120	**	35	**
WTD. AVG.	0.15	32600	22000	**	11000	**	3000	**	3500

7311783 SOUTH WICHITA R BLW LOW FLOW DAM NR GUTHRIE, TX
DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF MAR. 1988

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
MAR. 1988									
1	0.03	31500	21000	1.7	10000	0.85	3000	0.24	**
2	0.03	31400	21000	1.7	10000	0.85	3000	0.24	**
3	0.03	31300	21000	1.7	10000	0.84	2900	0.24	**
4	0.03	31200	21000	1.7	10000	0.84	2900	0.24	**
5	0.03	31100	21000	1.7	10000	0.84	2900	0.24	**
6	0.03	31000	21000	1.7	10000	0.84	2900	0.24	**
7	0.06	30700	21000	3.4	10000	1.7	2900	0.47	**
8	0.07	30300	20000	3.9	10000	1.9	2900	0.54	**
9	0.07	30200	20000	3.9	10000	1.9	2900	0.54	**
10	0.09	30200	20000	5.0	10000	2.4	2900	0.70	**
11	0.08	30100	20000	4.4	10000	2.2	2900	0.62	**
12	0.06	30100	20000	3.3	10000	1.6	2900	0.46	**
13	0.04	30100	20000	2.2	10000	1.1	2900	0.31	**
14	0.04	30000	20000	2.2	9900	1.1	2900	0.31	**
15	0.05	30000	20000	2.7	9900	1.3	2900	0.38	**
16	0.04	30100	20000	2.2	10000	1.1	2900	0.31	**
17	0.04	30200	20000	2.2	10000	1.1	2900	0.31	**
18	0.03	30200	20000	2.2	10000	1.1	2900	0.31	**
19	0.04	30300	20000	2.2	10000	0.81	2900	0.23	**
20	0.05	30300	20000	2.8	10000	1.4	2900	0.39	**
21	0.05	30300	20000	2.8	10000	1.4	2900	0.39	**
22	0.06	30400	21000	3.3	10000	1.6	2900	0.47	**
23	0.06	30500	21000	3.3	10000	1.6	2900	0.47	**
24	0.07	30600	21000	3.9	10000	1.9	2900	0.55	**
25	0.04	30600	21000	2.2	10000	1.1	2900	0.31	**
26	0.04	30700	21000	2.2	10000	1.1	2900	0.31	**
27	0.03	30800	21000	1.7	10000	0.83	2900	0.24	**
28	0.03	30900	21000	1.7	10000	0.83	2900	0.24	**
29	0.03	31000	21000	1.7	10000	0.84	2900	0.24	**
30	0.03	31100	21000	1.7	10000	0.84	2900	0.24	**
31	0.03	31000	21000	1.7	10000	0.84	2900	0.24	**
TOTAL	1.41	**	**	78	**	39	**	11	**
WTD. AVG.	0.05	30500	21000	**	10000	**	2900	**	3300

7311783 SOUTH WICHITA R BLW LOW FLOW DAM NR GUTHRIE, TX

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF APR. 1988

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHDS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
APR. 1988									
1	0.03	30900	21000	1.7	10000	0.83	2900	0.24	**
2	0.03	30700	21000	1.7	10000	0.83	2900	0.24	**
3	0.02	30500	21000	1.1	10000	0.55	2900	0.16	**
4	0.02	30400	21000	1.1	10000	0.54	2900	0.16	**
5	0.02	30300	20000	1.1	10000	0.54	2900	0.16	**
6	0.02	30300	20000	1.1	10000	0.54	2900	0.16	**
7	0.02	30300	20000	1.1	10000	0.54	2900	0.16	**
8	0.02	30200	20000	1.1	10000	0.54	2900	0.15	**
9	0.02	30200	20000	1.1	10000	0.54	2900	0.15	**
10	0.02	30100	20000	1.1	10000	0.54	2900	0.15	**
11	0.02	30100	20000	1.1	10000	0.54	2900	0.15	**
12	0.02	30000	20000	1.1	9900	0.54	2900	0.15	**
13	0.03	30000	20000	1.6	9900	0.80	2900	0.23	**
14	0.03	29900	20000	1.6	9900	0.80	2800	0.23	**
15	0.03	29900	20000	1.6	9900	0.80	2800	0.23	**
16	0.03	29800	20000	1.6	9900	0.80	2800	0.23	**
17	0.02	29800	20000	1.1	9900	0.53	2800	0.15	**
18	0.02	29700	20000	1.1	9800	0.53	2800	0.15	**
19	0.04	29700	20000	2.2	9800	1.1	2800	0.31	**
20	0.03	29700	20000	1.6	9800	0.80	2800	0.23	**
21	0.06	29600	20000	3.3	9900	1.6	2800	0.46	**
22	5.8	32500	22000	346	11000	170	3000	47	**
23	3.2	32900	22000	193	11000	95	3100	26	**
24	3.5	33000	22000	212	11000	105	3100	29	**
25	3.2	33400	23000	196	11000	97	3100	27	**
26	3.1	33500	23000	191	11000	94	3100	26	**
27	3.1	33700	23000	192	11000	95	3100	26	**
28	1.9	33900	23000	119	11000	59	3100	16	**
29	0.03	33600	23000	1.9	11000	0.92	3100	0.25	**
30	0.03	32300	22000	1.8	11000	0.88	3000	0.24	**
TOTAL	24.41	**	**	1500	**	730	**	200	**
WTD. AVG.	0.81	33100	23000	**	11000	**	3100	**	3600

APPENDIX E

SOUTH WICHITA RIVER NEAR BENJAMIN, TEXAS
(STATION NO. 7311800)
DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTHS
MAY 1987 - APR 1988

7311800 SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF MAY 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
MAY 1987									
1	7.9	21200	15000	311	6700	144	2600	55	**
2	7.9	21400	15000	314	6800	145	2600	56	**
3	7.9	21800	15000	320	7000	148	2600	56	**
4	7.9	21900	15000	322	7000	149	2600	56	**
5	7.8	22000	15000	319	7000	148	2600	56	**
6	6.2	22000	15000	254	7000	118	2600	44	**
7	6.1	22000	15000	249	7000	116	2600	44	**
8	5.6	21900	15000	228	7000	106	2600	40	**
9	5.5	21700	15000	222	6900	103	2600	39	**
10	13	20500	14000	496	6500	228	2500	89	**
11	8.7	20000	14000	324	6300	148	2500	59	**
12	7.1	20000	14000	264	6300	121	2500	48	**
13	8.8	20000	14000	327	6300	150	2500	59	**
14	8.2	14700	10000	225	4500	100	2000	45	**
15	5.4	19900	14000	200	6300	92	2500	36	**
16	4.8	21500	15000	192	6900	89	2600	34	**
17	4.4	22700	16000	186	7300	87	2700	32	**
18	3.5	23800	18000	155	7700	73	2800	26	**
19	13	21000	14000	508	6700	234	2600	90	**
20	9.9	14700	10000	271	4500	120	2000	54	**
21	5.1	16300	11000	155	5000	69	2200	30	**
22	123	7990	5500	1840	2400	781	1200	405	1400
23	1090	5850	4100	11900	1700	5000	920	2710	1000
24	112	6410	4400	1340	1900	565	1000	303	1100
25	49	7040	4900	645	2100	273	1100	144	1200
26	34	7540	5200	479	2200	203	1200	106	1300
27	139	6220	4300	1570	1800	660	970	355	1100
28	1850	1380	920	4790	390	1950	230	1160	260
29	2530	2100	1500	9960	600	4070	350	2380	390
30	1440	2100	1500	5670	600	2320	350	1360	390
31	190	3680	2600	1310	1100	541	600	307	670
TOTAL	7706	**	**	45000	**	19000	**	10000	**
WTD. AVG.	249	3150	2200	**	920	**	490	**	560

7311700 SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

DAILY AND MONTHLY HEARS AND LOADS FOR THE MONTH OF JUNE 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHDS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
JUNE 1987									
1	100	5200	3600	985	1500	411	840	226	940
2	76	6840	4700	973	2000	410	1100	218	1200
3	57	7530	5200	802	2200	340	1200	178	1300
4	48	7490	5200	672	2200	285	1200	149	1300
5	57	9430	6500	652	2800	280	1400	141	1600
6	30	5830	4000	527	1700	137	920	74	1000
7	24	5170	3600	332	1500	97	820	53	920
8	21	5130	3600	204	1500	85	820	47	930
9	48	5430	3800	488	1600	204	860	112	970
10	39	5820	4100	428	1700	179	920	97	1000
11	48	7820	5400	706	2300	300	1200	156	1400
12	29	7570	5200	411	2200	174	1200	91	1300
13	18	6500	4500	220	1900	93	1000	50	1200
14	11	7850	5500	162	2300	69	1200	36	1400
15	9.2	8230	5700	141	2400	60	1300	31	1400
16	7.2	11900	8200	160	3600	70	1700	33	**
17	5.4	15800	11000	159	4900	71	2100	31	**
18	4.6	15000	10000	129	4600	57	2000	25	**
19	4.9	13900	9600	127	4200	56	1900	26	**
20	935	5910	4100	10300	1700	4340	930	2350	1000
21	536	4780	3300	4800	1400	2000	760	1110	860
22	127	4450	3100	1060	1300	440	720	246	800
23	113	2850	2000	604	810	248	470	143	520
24	101	3460	2400	659	1000	272	570	155	630
25	101	4720	3300	893	1400	371	760	206	850
26	81	7010	4900	1060	2100	449	1100	237	1200
27	71	6170	4300	820	1800	344	970	185	1100
28	71	6070	4200	807	1800	339	950	183	1100
29	248	6290	4300	3490	1800	1460	980	788	1100
30	175	8620	6000	2840	2600	1210	1300	619	1500
TOTAL	3226	**	**	35000	**	15000	**	8000	**
MTD. AVG.	108	5850	4100	**	1700	**	920	**	1000

7311200

SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF JULY 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA.MG) (MG/L)
JULY 1987									
1	53	8620	6000	854	2500	365	1300	186	1500
2	43	8820	6100	709	2600	303	1300	154	1500
3	37	8980	6200	621	2700	266	1400	135	1600
4	32	10000	6900	598	3000	257	1500	128	**
5	30	10800	7500	605	3200	262	1600	128	**
6	27	11400	7900	575	3400	250	1700	120	**
7	24	12100	8400	542	3700	237	1700	112	**
8	22	12600	8700	517	3800	227	1800	106	**
9	21	13200	9100	517	4000	227	1900	105	**
10	20	13800	9500	515	4200	227	1900	104	**
11	19	14300	9900	507	4400	224	2000	101	**
12	20	14500	10000	541	4400	240	2000	108	**
13	117	6140	4300	1340	1800	565	960	304	1100
14	23	6730	4700	290	2000	122	1000	65	1200
15	20	9990	6900	373	3000	161	1500	80	1700
16	32	10000	6900	598	3000	257	1500	128	**
17	80	3300	2300	495	940	204	540	116	600
18	28	3280	2300	160	940	66	540	38	600
19	66	3450	2400	427	990	176	560	100	630
20	48	8320	5800	747	2500	318	1300	164	1400
21	44	13200	9100	1080	4000	476	1900	221	**
22	26	13300	9200	645	4000	284	1900	131	**
23	22	13300	9200	546	4000	240	1900	111	**
24	20	13400	9300	500	4100	220	1900	101	**
25	18	13400	9300	450	4100	198	1900	91	**
26	17	13600	9400	431	4100	190	1900	87	**
27	16	13700	9500	409	4200	180	1900	83	**
28	15	13800	9500	386	4200	170	1900	78	**
29	14	13800	9500	360	4200	159	1900	73	**
30	14	13900	9600	363	4200	160	1900	73	**
31	13	14000	9700	339	4300	150	1900	68	**
TOTAL	979	**	**	17000	**	7400	**	3600	**
WTD. AVG.	32	9320	6400	**	2800	**	1400	**	1600

7311800

SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF AUG. 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA.MG) (MG/L)
AUG. 1987									
1	12	14000	9700	313	4300	138	1900	63	**
2	11	14000	9700	287	4300	127	1900	58	**
3	11	14100	9700	289	4300	128	2000	58	**
4	82	11700	8100	1790	3500	780	1700	373	**
5	129	2920	2000	706	830	290	480	167	530
6	17	9020	6200	287	2700	123	1400	62	1600
7	13	11000	7600	267	3300	116	1600	56	**
8	11	12000	8300	246	3600	107	1700	51	**
9	10	13000	9000	243	3900	106	1800	50	**
10	9 7	14000	9700	253	4300	112	1900	51	**
11	9 5	15000	10000	266	4600	118	2000	53	**
12	9 1	15000	10000	254	4600	113	2000	50	**
13	21	13400	9300	525	4100	231	1900	107	**
14	9 9	8400	5800	155	2500	66	1300	34	1500
15	7 6	12500	8600	177	3800	78	1800	36	**
16	17	12400	8600	393	3700	172	1800	81	**
17	15	13300	9200	372	4000	164	1900	76	**
18	7 7	11000	7600	158	3300	69	1600	33	**
19	6 3	12000	8300	141	3600	62	1700	29	**
20	5 7	12500	8600	133	3800	58	1800	27	**
21	5 2	13000	9000	126	3900	55	1800	26	**
22	4 8	13500	9300	121	4100	53	1900	24	**
23	4 5	14000	9700	118	4300	52	1900	24	**
24	4 3	14500	10000	116	4400	52	2000	23	**
25	4 0	15000	10000	112	4600	50	2000	22	**
26	18	10800	7500	363	3200	157	1600	77	**
27	159	3600	2500	1070	1000	443	590	251	650
28	13	7100	4900	173	2100	73	1100	39	1200
29	13	8000	5500	194	2400	83	1200	43	1400
30	10	11000	7600	205	3300	89	1600	43	**
31	9 1	12000	8300	204	3600	89	1700	42	**
TOTAL	659	**	**	10000	**	4400	**	2100	**
WTD. AVG.	21	8170	5700	**	2400	**	1200	**	1400

7311800

SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF SEPT 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
SEPT 1987									
1	7.7	13000	9000	187	3900	82	1800	38	**
2	5.9	14000	9700	154	4300	68	1900	31	**
3	5.0	14900	10000	139	4600	62	2000	28	**
4	4.4	15500	11000	127	4800	57	2100	25	**
5	3.8	15800	11000	112	4900	50	2100	22	**
6	3.8	15600	11000	110	4800	49	2100	22	**
7	3.7	16100	11000	111	5000	50	2200	22	**
8	3.2	16200	11000	97	5000	43	2200	19	**
9	2.9	16500	11000	89	5100	40	2200	17	**
10	2.8	16500	11000	86	5100	39	2200	17	**
11	2.5	16500	11000	77	5100	34	2200	15	**
12	4.5	9600	6600	81	2900	35	1400	17	**
13	8.3	4400	3100	684	1300	284	710	159	1600
14	19	6100	4200	217	1800	91	960	49	790
15	11	7800	5400	160	2300	68	1200	35	1100
16	7.9	8100	5600	120	2400	51	1200	26	1400
17	10	8800	6100	165	2600	70	1300	36	1400
18	24	7310	5100	328	2100	139	1100	73	1500
19	8.4	12200	8400	191	3700	84	1700	40	1300
20	5.6	12300	8500	129	3700	56	1800	27	**
21	4.5	12500	8600	105	3800	46	1800	22	**
22	3.9	12600	8700	92	3800	40	1800	19	**
23	3.6	12700	8800	85	3800	37	1800	18	**
24	3.2	12800	8800	76	3900	34	1800	16	**
25	2.5	12900	8900	60	3900	26	1800	12	**
26	2.3	13000	9200	55	4000	24	1800	11	**
27	1.9	13600	9400	47	4100	21	1900	9.6	**
28	2.6	13800	9500	66	4200	29	1900	13	**
29	2.0	15000	10000	51	4600	23	2000	10	**
30	1.8			50		22		10.0	**
TOTAL	247	**	**	4100	**	1800	**	860	**
WTD. AVG.	8.2	8770	6100	**	2600	**	1300	**	1500

7311800

SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF OCT. 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
OCT. 1987									
1	1.6	16200	11000	48	5000	22	2200	9.4	**
2	1.5	16300	11000	46	5000	20	2200	8.8	**
3	1.3	16500	11000	40	5100	18	2200	7.7	**
4	1.3	16500	11000	40	5100	18	2200	7.7	**
5	1.3	16700	12000	40	5200	18	2200	7.8	**
6	1.3	16900	12000	41	5200	18	2200	7.8	**
7	1.2	16800	12000	38	5200	17	2200	7.2	**
8	1.1	16700	12000	34	5200	15	2200	6.6	**
9	1.1	16900	12000	35	5200	16	2200	6.6	**
10	1.1	17100	12000	35	5300	16	2300	6.7	**
11	1.1	17000	12000	35	5300	16	2200	6.7	**
12	1.2	17100	12000	38	5300	17	2300	7.3	**
13	1.4	17000	12000	44	5300	20	2200	8.5	**
14	1.3	17000	12000	41	5300	19	2200	7.9	**
15	1.4	16700	12000	44	5200	20	2200	8.4	**
16	1.6	16900	12000	50	5200	23	2200	9.6	**
17	1.7	16900	12000	54	5200	24	2200	10	**
18	1.9	17200	12000	61	5300	27	2300	12	**
19	1.7	16500	11000	52	5100	23	2200	10	**
20	1.3	16700	12000	40	5200	18	2200	7.8	**
21	1.0	16300	11000	30	5000	14	2200	5.9	**
22	1.1	16800	12000	34	5200	15	2200	6.6	**
23	1.2	16800	12000	38	5200	17	2200	7.2	**
24	1.4	16900	12000	44	5200	20	2200	8.4	**
25	1.5	16900	12000	47	5200	21	2200	9.0	**
26	1.4	17100	12000	45	5300	20	2300	8.5	**
27	1.3	16500	11000	40	5100	18	2200	7.7	**
28	1.5	17100	12000	48	5300	22	2300	9.1	**
29	1.6	17200	12000	51	5300	23	2300	9.8	**
30	1.3	17300	12000	42	5400	19	2300	8.0	**
31	0.9	17400	12000	30	5400	13	2300	5.7	**
TOTAL	42	**	**	1300	**	590	**	250	**
WTD. AVG.	1.3	16800	12000	**	5200	**	2200	**	2700

SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

MONTH	YEAR
NOV.	1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
NOV. 1987									
1	0.71	17400	12000	23	5400	10	2300	4.4	**
2	0.62	17500	12000	20	5500	9.1	2300	3.8	**
3	0.55	17200	12000	18	5300	7.9	2300	3.4	**
4	0.67	17100	12000	21	5300	9.6	2300	4.1	**
5	0.69	17200	12000	22	5300	10.0	2300	4.2	**
6	0.59	17300	12000	19	5400	8.6	2300	3.6	**
7	0.55	17700	12000	18	5500	8.2	2300	3.4	**
8	0.59	17700	12000	19	5500	8.8	2300	3.7	**
9	0.66	17500	12000	21	5400	9.6	2300	4.0	**
10	0.64	17400	12000	21	5400	9.4	2300	3.9	**
11	0.67	17400	12000	22	5400	9.8	2300	4.1	**
12	0.91	17900	12000	30	5600	14	2300	5.7	**
13	1.1	18400	13000	38	5800	17	2400	7.0	**
14	1.3	18900	13000	46	5900	21	2400	8.5	**
15	1.4	18800	13000	49	5900	22	2400	9.1	**
16	1.3	18800	13000	45	5900	21	2400	8.4	**
17	1.2	18500	13000	41	5800	19	2400	7.7	**
18	1.3	17900	12000	43	5600	20	2300	8.2	**
19	1.2	18500	13000	41	5800	19	2400	7.7	**
20	1.2	18400	13000	41	5800	19	2400	7.7	**
21	1.3	18900	13000	46	5900	21	2400	8.5	**
22	1.4	19200	13000	50	6000	23	2400	9.2	**
23	1.5	19200	13000	54	6000	24	2400	9.9	**
24	1.6	19200	13000	57	6000	26	2400	11	**
25	1.6	19500	13000	58	6100	27	2500	11	**
26	1.6	19600	14000	58	6200	27	2500	11	**
27	1.7	19500	13000	62	6100	28	2500	11	**
28	1.8	19500	13000	65	6100	30	2500	12	**
29	1.9	19800	14000	70	6200	32	2500	13	**
30	2.0	19600	14000	73	6200	33	2500	13	**
TOTAL	34.25	**	**	1200	**	540	**	220	**
WTD. AVG.	1.1	18700	13000	**	5900	**	2400	**	2900

7311800

SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF DEC. 1987

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
1	1.9	19700	14000	70	6200	32	2500	13	**
2	2.0	19500	13000	73	6100	33	2500	13	**
3	2.1	19400	13000	76	6100	35	2500	14	**
4	2.1	19400	13000	76	6100	35	2500	14	**
5	2.1	19300	13000	75	6100	34	2400	14	**
6	2.2	19300	13000	79	6100	36	2400	15	**
7	1.9	19400	13000	69	6100	31	2500	13	**
8	2.0	19500	13000	73	6100	33	2500	13	**
9	1.9	19200	13000	68	6000	31	2400	12	**
10	1.9	19500	13000	69	6100	32	2500	13	**
11	2.0	19500	13000	73	6100	33	2500	13	**
12	1.9	19500	13000	69	6100	32	2500	13	**
13	1.9	19600	14000	69	6200	32	2500	13	**
14	2.6	19600	14000	102	6200	47	2500	19	**
15	3.3	19200	13000	118	6000	54	2400	22	**
16	3.2	19300	13000	115	6100	52	2400	21	**
17	3.2	19300	13000	115	6100	52	2400	21	**
18	3.5	18800	13000	122	5900	56	2400	23	**
19	3.2	18200	13000	108	5700	49	2400	20	**
20	3.6	18100	12000	121	5700	55	2300	23	**
21	3.6	18100	12000	121	5700	55	2300	23	**
22	3.3	18100	12000	111	5700	50	2300	21	**
23	3.2	17900	12000	107	5600	48	2300	20	**
24	3.2	17900	12000	107	5600	48	2300	20	**
25	11	17700	12000	363	5500	164	2300	68	**
26	7.3	16600	11000	226	5100	101	2200	43	**
27	6.0	13500	9300	151	4100	67	1900	31	**
28	7.0	11600	8000	152	3500	66	1700	32	**
29	6.7	14800	10000	185	4500	82	2000	37	**
30	5.3	14400	9900	142	4400	63	2000	28	**
31	5.2	14800	10000	143	4500	64	2000	28	**
TOTAL	110.5	**	**	3500	**	1600	**	670	**
WTD. AVG.	3.6	17200	12000	**	5400	**	2300	**	2700

7311800 SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.
DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF JAN. 1988

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
1	5.0	15300	11000	143	4700	64	2100	28	**
2	4.5	15200	10000	128	4700	57	2100	25	**
3	4.3	15200	10000	122	4700	54	2100	24	**
4	4.0	15500	11000	116	4800	52	2100	23	**
5	3.8	15500	11000	110	4800	49	2100	22	**
6	3.6	15400	11000	103	4700	46	2100	20	**
7	3.5	16600	11000	108	5100	49	2200	21	**
8	3.4	16000	11000	101	4900	45	2100	20	**
9	3.4	16000	11000	101	4900	45	2100	20	**
10	3.4	15900	11000	101	4900	45	2100	20	**
11	3.5	15300	11000	100	4700	44	2100	20	**
12	7.6	15500	11000	220	4800	98	2100	43	**
13	5.9	15800	11000	174	4900	78	2100	34	**
14	5.5	15800	11000	162	4900	72	2100	32	**
15	7.3	15800	11000	215	4900	96	2100	42	**
16	9.0	15800	11000	265	4900	118	2100	52	**
17	9.4	14800	10000	259	4500	115	2000	51	**
18	9.8	14200	9800	260	4300	115	2000	52	**
19	9.6	14500	10000	260	4400	115	2000	52	**
20	8.9	14500	10000	241	4400	107	2000	48	**
21	8.5	14400	9900	228	4400	101	2000	46	**
22	7.6	14300	9900	203	4400	90	2000	41	**
23	7.2	14800	10000	199	4500	88	2000	39	**
24	5.9	16400	11000	180	5100	81	2200	35	**
25	4.8	16700	12000	149	5200	67	2200	29	**
26	4.5	16500	11000	138	5100	62	2200	27	**
27	4.1	16300	11000	125	5000	56	2200	24	**
28	3.9	16000	11000	116	4900	52	2100	23	**
29	3.6	15800	11000	106	4900	47	2100	21	**
30	3.3	16100	11000	99	5000	44	2200	19	**
31	3.3	16400	11000	101	5100	45	2200	19	**
TOTAL	172.1	**	**	4900	**	2200	**	970	**
WTD. AVG.	5.6	15400	11000	**	4700	**	2100	**	2500

7311200 SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.
DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF FEB. 1988

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
FEB. 1988									
1	3.3	16900	12000	104	5200	47	2200	20	**
2	3.2	17500	12000	104	5500	47	2300	20	**
3	3.5	17700	12000	115	5500	52	2300	22	**
4	3.4	17500	12000	113	5600	51	2300	21	**
5	3.9	17700	12000	129	5500	58	2300	24	**
6	4.6	17300	12000	148	5400	67	2300	28	**
7	4.1	17300	12000	132	5400	60	2300	25	**
8	4.0	17600	12000	131	5500	59	2300	25	**
9	3.8	17800	12000	126	5600	57	2300	24	**
10	3.6	18200	13000	122	5700	55	2400	23	**
11	3.2	20500	14000	122	6500	56	2500	22	**
12	3.7	19300	13000	133	6100	61	2400	24	**
13	3.3	17800	12000	109	5600	49	2300	21	**
14	3.1	18200	13000	105	5700	48	2400	20	**
15	2.5	18300	13000	85	5700	39	2400	16	**
16	2.6	18200	13000	88	5700	40	2400	16	**
17	2.3	18200	13000	78	5700	35	2400	15	**
18	2.2	18200	13000	75	5700	34	2400	14	**
19	2.4	18200	13000	81	5700	37	2400	15	**
20	2.5	18200	13000	85	5700	38	2400	16	**
21	2.3	18100	12000	78	5700	35	2300	15	**
22	2.5	18300	13000	85	5700	39	2400	16	**
23	2.2	18600	13000	77	5900	35	2400	14	**
24	1.9	18600	13000	66	5800	30	2400	12	**
25	2.4	18400	13000	82	5800	37	2400	15	**
26	2.7	18500	13000	93	5800	42	2400	17	**
27	2.7	18700	13000	94	5900	43	2400	17	**
28	2.3	18700	13000	80	5900	36	2400	15	**
29	2.2	18900	13000	77	5900	35	2400	14	**
TOTAL	86.4	**	**	2900	**	1300	**	550	**
WTD. AVG.	3.0	18100	13000	**	5700	**	2300	**	2900

7311200

SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF MAR. 1988

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
1	2.0	18700	13000	70	5900	32	2400	13	**
2	30	8840	6100	496	2600	212	1300	108	1500
3	13	3520	2400	86	1000	35	570	20	640
4	5.8	7120	4900	77	2100	33	1100	17	1300
5	5.2	11000	7600	107	3300	46	1600	23	**
6	5.0	14600	10000	136	4500	60	2000	27	**
7	4.5	16800	12000	141	5200	63	2200	27	**
8	4.0	17300	12000	129	5400	58	2300	25	**
9	3.6	17400	12000	117	5400	53	2300	22	**
10	3.3	17900	12000	110	5600	50	2300	21	**
11	3.0	17800	12000	99	5600	45	2300	19	**
12	2.5	18000	12000	84	5600	38	2300	16	**
13	2.2	18300	13000	75	5700	34	2400	14	**
14	2.3	18500	13000	79	5800	36	2400	15	**
15	2.3	18600	13000	80	5800	36	2400	15	**
16	2.2	18600	13000	76	5800	35	2400	14	**
17	2.8	17900	12000	93	5600	42	2300	18	**
18	2.7	18000	12000	90	5600	41	2300	17	**
19	2.7	18000	12000	90	5600	41	2300	17	**
20	2.5	18300	13000	85	5700	39	2400	16	**
21	2.5	18400	13000	86	5800	39	2400	16	**
22	2.3	18600	13000	80	5800	36	2400	15	**
23	2.3	18900	13000	81	5900	37	2400	15	**
24	2.0	19100	13000	71	6000	32	2400	13	**
25	1.7	19100	13000	60	6000	28	2400	11	**
26	1.5	19500	13000	54	6100	25	2500	10.0	**
27	1.2	19500	13000	44	6100	20	2500	8.0	**
28	1.3	19600	14000	47	6200	22	2500	8.7	**
29	1.2	19800	14000	44	6200	20	2500	8.0	**
30	1.1	19900	14000	41	6300	19	2500	7.4	**
31	1.3	19600	14000	47	6200	22	2500	8.7	**
TOTAL	120	**	**	3000	**	1300	**	580	**
WTD. AVG.	3.9	13500	9200	**	4100	**	1800	**	2200

7311800

SOUTH WICHITA RIVER NEAR BENJAMIN, TEX.

DAILY AND MONTHLY MEANS AND LOADS FOR THE MONTH OF APR. 1988

MONTH YEAR	DISCHARGE (CFS-DAYS)	SPECIFIC CONDUCT- ANCE (MICRO- MHOS)	DIS- SOLVED SOLIDS (MG/L)	DIS- SOLVED SOLIDS (TONS)	DIS- SOLVED CHLORIDE (MG/L)	DIS- SOLVED CHLORIDE (TONS)	DIS- SOLVED SULFATE (MG/L)	DIS- SOLVED SULFATE (TONS)	HARDNESS (CA, MG) (MG/L)
1	1.7	19200	13000	61	6000	28	2400	11	**
2	2.2	19600	14000	80	6200	37	2500	15	**
3	2.1	19800	14000	77	6200	35	2500	14	**
4	1.9	19800	14000	70	6200	32	2500	13	**
5	1.8	20100	14000	67	6400	31	2500	12	**
6	1.6	20000	14000	60	6300	27	2500	11	**
7	1.5	19700	14000	55	6200	25	2500	10	**
8	1.3	20100	14000	49	6400	22	2500	8.8	**
9	1.3	20300	14000	49	6400	23	2500	8.9	**
10	1.9	19800	14000	70	6200	32	2500	13	**
11	1.6	20000	14000	60	6300	27	2500	11	**
12	1.4	20800	14000	54	6600	25	2500	9.7	**
13	1.4	20400	14000	53	6500	24	2500	9.6	**
14	1.3	20600	14000	50	6500	23	2500	8.9	**
15	1.2	20600	14000	46	6500	21	2500	8.3	**
16	1.2	20500	14000	46	6500	21	2500	8.2	**
17	35	5250	3600	344	1500	144	830	79	940
18	15	6000	4200	168	1700	71	940	38	1100
19	6.4	8000	5500	96	2400	41	1200	21	1400
20	5.0	11700	8100	109	3500	48	1700	23	**
21	5.0	15400	11000	144	4700	64	2100	28	**
22	4.4	16900	12000	139	5200	62	2200	27	**
23	3.5	17200	12000	112	5300	51	2300	21	**
24	2.7	17700	12000	89	5500	40	2300	17	**
25	2.3	19400	13000	83	6100	38	2500	15	**
26	2.1	19600	14000	77	6200	35	2500	14	**
27	1.6	19100	13000	57	6000	26	2400	10	**
28	2.3	19200	13000	82	6000	38	2400	15	**
29	3.7	20100	14000	138	6400	63	2500	25	**
30	4.1	20400	14000	156	6500	72	2500	28	**
TOTAL	118.5	**	**	2700	**	1200	**	530	**
WTD. AVG.	4.0	12400	8600	**	3800	**	1700	**	2000